PRESERVATION OF TIMBER

SOUVENIR EDITION

(REVISED)

1909

ROWE

THE AUTHOR.

Hand Book of Timber Preservation

Souvenir Edition
Revised

By Samuel M. Rowe, C. E.
M. Am. Soc. C. E. and M. W. S. E.
Mem. A. R. E. & M. of W. Assn.

CHICAGO
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1904

ROBERT DELOS ROWE (Deceased).

M. AM. SOC. C. E.

To whose labors and intelligent studies and investigations much that is most valuable in this work is due, this book is affectionately dedicated.

PREFACE.

"Since 1885, when the matter was first taken up under the tutelage of the late Joseph P. Card, the author has labored to perfect the methods and appliances, studying each principle and all questions connected with the operation of timber preserving in the direction of convenience, economy and effectiveness. Most of the matter contained is original, and this is the first attempt made to furnish a complete practical guide for the operator, containing full directions, that has been made in this country. Those so far operating works of this kind have relied upon training their own operator and carefully refraining from letting any but general items of information go out.

In a general way, the book is an epitome of the experience and observations of the author, assisted by Robert D. Rowe, recently deceased, giving results of much labor, study and time.

It is not pretended that the operator can take the matter up from the book and proceed at once to run the business, as there is too much that calls for a trained and matured judgment; but the book will be of much service as a handbook and guide during the operation of the plant as well as to hints during the construction.

The author is but too sensible of the imperfect arrangement of the work and that much is yet to do to make it complete, but trusts to be able to offer in the near future an edition that will correct, to some extent, the imperfections of this."

The Souvenir Edition of the Handbook on Timber Preservation issued in 1900 is now exhausted, and to meet the ever increasing demand for information on the practical side of this subject would seem to justify another edition. To meet this demand, the second edition is published after being revised and extended in its scope somewhat.

An effort is made to bring in the writing of other experienced men, as well as to add many items of experience and results of experiments that will aid the student and operator in a fuller understanding of the principles involved in the operation, the nature of the chemicals used, and the character of the woods treated.

The former work has been criticised, some of the statements declared wrong and the conclusions erroneous. That there were mistakes and grounds for criticism is not denied, and where they have been pointed out the critic has the thanks of the author. The author does not claim a high degree of erudition, but has tried to give the facts derived from long practical experience in the business, in a manner to be understood by any man of average intelligence.

In all cases care has been taken to give proper credit where matter has been copied from other authors. Some of the other processes are noticed in a brief way, giving such information as came into reach in the publications of the promoters. Octave Chanute, C. E., John D. Isaacs of the Southern Pacific Railway, President E. P. Ripley and General Manager Mudge, both of the A., T. & S. F. Ry., deserve special mention as furnishing much information that has aided in this compilation.

PRESERVATION OF TIMBER.

INTRODUCTORY.

Section 1. The primary purpose of this treatise is to furnish and collate such information as to the practical workings as shall enable the operator to fully understand the philosophy and principles involved, and to serve as a hand book of information, both during the construction of the works and during the operation of the same.

In the preservation of timber, the machinery to be used, as well as the movements and methods used in the operation of the process, are somewhat complex; just as in the manufacture of steel, in the process of making or refining sugar or of almost anv line of mechanical business, so that to insure proper results the operator must not only have a thorough knowledge of the principles involved, but must have a thorough training in the method of handling the plant.

In the first place, the works are expensive, the amount of capital involved in the erection and equipment is a very large amount; then the chemicals are costly, hence any mistake in handling or failure to do good work is an expensive mistake, indeed.

The appliances for the treatment of timber have been brought to such a degree of efficiency that, if properly handled, there is little chance of failure or disappointment in the results.

VARIOUS PROCESSES USED.

Sec. 2. While, as generally conceded, the use of dead oil product of coal tar, usually called creosote, has shown in some cases high results, yet for sev-

eral reasons reference to it will be but incidental, and attention will be given almost exclusively to that of the Burnett and to the Zinc-Tannin or Wellhouse processes, in which the chloride of zinc is the preservative agent. There are two reasons why the creosote process will be largely restricted in its use. In the first place, the process is very expensive, the oil being more and more costly from year to year, and in the second place, there is the difficulty and uncertainty of getting a suitable article. Its much greater cost will necessarily restrict its use to cases where the amount of timber is small and the lasting quality of the timber paramount.

On the other hand, the zinc-tannin process, costing but a fraction of that of the former, has been found only less effective, showing an economy that is very marked. especially when applied to the treatment of railroad cross-ties and bridge timber. It is therefore the purpose to treat here of this matter with reference to this line of work.

As the Wellhouse process is a modification of the Burnett, the latter will be noticed only incidentally, but the former, being the more complex, will be treated of at length.

ZINC-TANNIN OR WELLHOUSE PROCESS.

METHODS AND RULES.

Sec. 3. The Zinc-Tannin or Wellhouse process for treating and preserving railroad cross-ties, bridge or other timbers against early decay, consists in first subjecting the timber to the action of steam in an air-tight, sealed retort for such length of time as is found necessary to open the pores of the timber and loosen and expel the natural saps. This is followed by a vacuum of from 18 to 26 inches, thereby withdrawing all the vapors and freeing the timber from condensations of steam introduced and of the volatilized saps.

Sec. 4. This is followed by the introduction of zinc-chloride in solution one and a half to three per

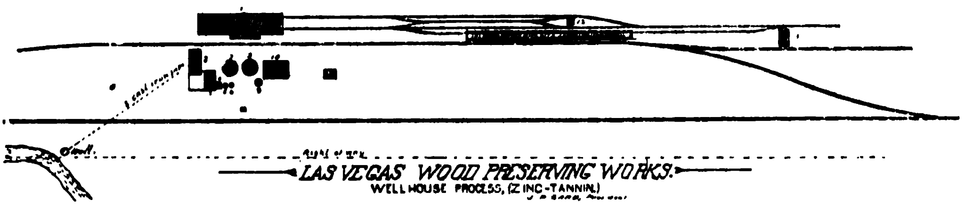

FIG. 1—ORIGINAL YARD (LAS VEGAS).

cent strong, as the character of the timber under treatment shall require, the solution carrying at the same time one-half of one per cent in weight of dissolved glue.

This solution is held under pressure of 100 pounds for a period of two and one-half hours to six hours, depending, as before, on the character and condition of the timber treated.

Sec. 5. The retort is then freed by forcing the chloride solution back into its receptacle and introducing a one-half of one per cent solution of tannin and holding it under pressure, as with the zinc and glue, for two hours or thereabout and then withdrawing it, completing the operation. This process is sometimes varied by introducing the glue in a separate solution, in which case a separate tub will be necessary for the glue solution.

Sec. 6. This process under consideration differs from the Burnett only in the addition of the glue followed by the tannin, the glue and the tannin combining and forming a leathery and insoluble product which helps to render the timber impervious to the absorption and giving off of water, so protecting the chloride, which is supposed to be easily washed out of the timber, thus losing its antiseptic effect.

Sec. 7. The wide range in time is necessary to meet the difference in the character and condition of the timber, and the proper and most economical and effective practice can only be fixed by first determining what absorption can be secured, and thenceforward conforming to this. This can best be done by varying the time or the strength of the solution, or both.

Sec. 8. A very important requirement is that the timber being treated shall have a reasonable amount of seasoning, say sixty to ninety days, varying in length of time as climatic conditions shall vary.

In a warm, dry climate, sixty days may be ample, while in a moist, cold climate much more time will be necessary to fit the timber for good results.

Sec. 9. That a sufficient amount of antiseptic be introduced, and its thorough dissemination through the piece, is the essential point to be attained.

It is only by careful observation and study by an experienced management that the best results can be secured.

CAUTION.

Sec. 10. The process and methods here outlined have been in practice many years with results that place them beyond the sphere of experiment, hence any departure from them with a view to improve should be guarded against and deprecated by the management. Any experiments in the direction of improvement should be made by those competent to direct and situated to carry out a long series of experiments. Even this should be attempted with caution and hesitation, as it takes long to get definite results.

APPLIANCES.

Sec. 11. The appliances used are much the same as those for the Burnett or creosote processes, the minor appliances for preparing the chemicals only differing. In each and all the steaming is identical, and the storing tanks and piping are interchangeable from one process to the other.

First—The steam plant for furnishing the necessary steam to the retort, for driving the different pumps and machinery, including a dynamo to furnish light, and to steam coils for heating the works.

The electric light is quite essential, as the works should run night and day.

Second—The retort, sometimes called the cylinder, made of steel plate, and of such dimensions as will receive the charge with its tram cars on which the timber is loaded in such shape as to fill the cylinder as nearly as possible. The retort most convenient is usually about 106 feet in clear length, capable of receiving thirteen tram cars with their

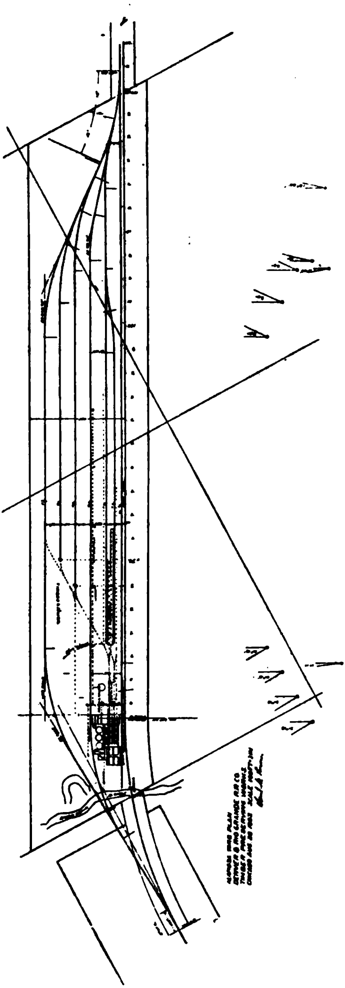

FIG. 2—ALAMOSA YARD

loads of eight-feet ties, and of such diameter as is deemed most suitable and convenient, generally about six feet. It contains tracks on which the tram cars run, the gauge of which is the same as that of the tram-yard tracks, by means of which the charge is run in and out.

The retort is provided with a strong door, self-sealing, or may be hand-bolted as may be desired, fitting tightly to resist pressure and to prevent leakage and waste.

THE "SPIDER" DOOR.

The retort door, as shown in Fig. 4, is old as to its general form, but has lately been improved in its details so that it proves economical even at an increased cost. The door with its hinge arms is cast in one piece, from cast steel with a large reduction of thickness over that of a cast iron door. It is faced in the lathe and fitted with stud screw 4 inches in diameter; the hub is fitted with a bronze bushing working closely on the buttressed thread of the screw, and the friction plates, made of the finest tool steel, have two circles of steel balls, which almost entirelv eliminates friction, enabling it to close quickly and with the least amount of labor.

Ordinarily only one door is necessary, aside from avoiding the expense of a second door, complications in the appliances and the operation of charging the retort, no special advantage is derived from such an arrangement, as the confining of operation to the one point is believed to be the most economical.

The weight of the cast steel spider door is about 6.500 lbs.

WEIGHT OF CASTING FOR CAST STEEL DOOR, FOR RETORT.

Dia. 78½"-2½" thick. 14,486 cu. in.
Extra at hub, 810 cu. in.

$$\frac{-15{,}296 \text{ cu. in.}}{1{,}728''}$$

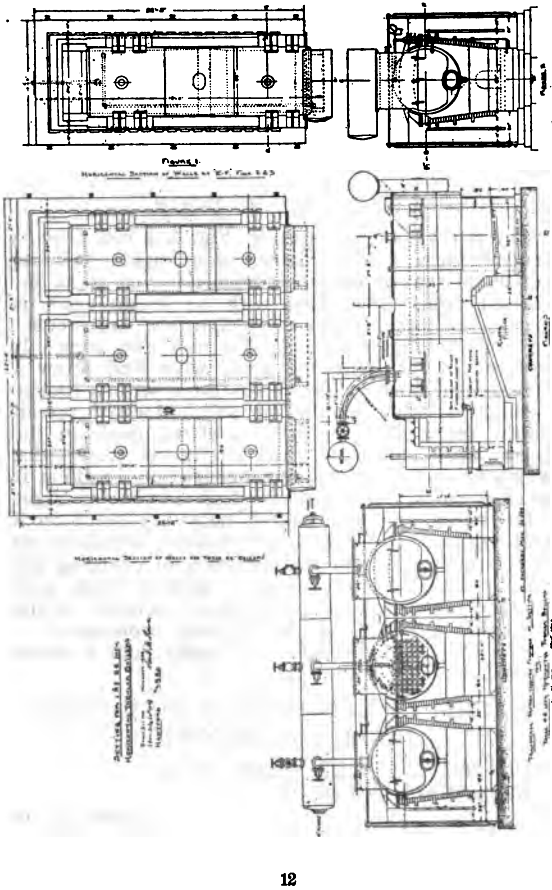

FIG. 3—STEAM BOILERS.

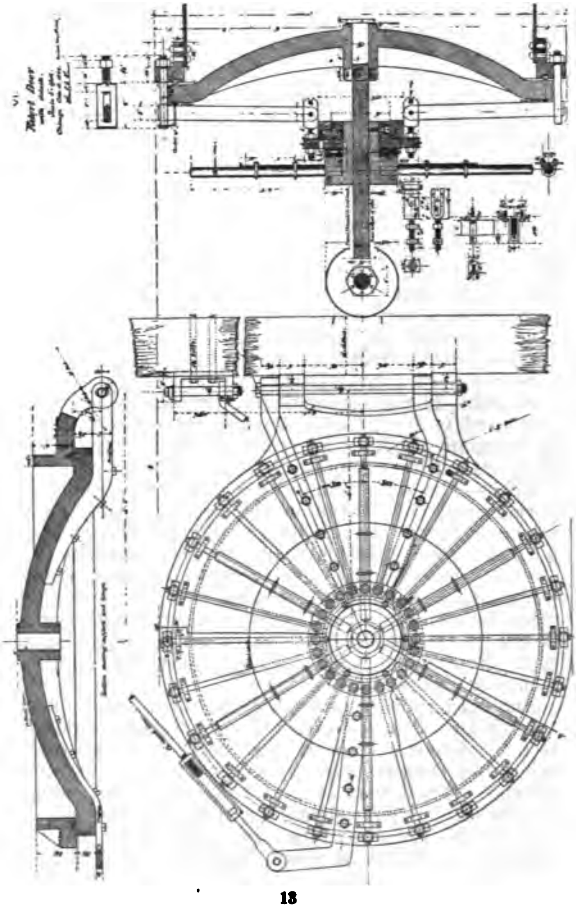

FIG. 4—SPIDER DOOR.

equal 8.852 cu. ft. × 490 lbs. equal 4,337.5 lbs. cast steel—say 4,400 lbs. exclusive of hub and fixtures.—
Hingearms 200

4,600

For hub, add 700 lbs.

Other fittings, 500 lbs., and stud screw, 750 lbs., making a total of 6,300 lbs.—say, 6,500 lbs.

Third—The vacuum pump, used to free the retort from air and vapors remaining after the steam has been released from it, to encourage the outflow of natural saps of the timber and to prepare it for the ready absorption of the solution by freeing it from hot vapors and expanding the small amount of vapors remaining. In connection with the vacuum pump, and a very important adjunct, is the surface condenser and the hot-well, by which the vapors are condensed before reaching the vacuum pump, relieving it of a large part of its labors.

Fourth—The air compressor, by which the solution used is forced back into its receptacle quickly, by pumping air into the retort, as well as for other purposes where compressed air is desired.

Fifth—The force pump, by which pressure is produced upon the charge in the retort, a boiler-feed pump, a pump for handling water for the various purposes about the plant and for fire security.

Sixth—Large tanks or receptacles for the various solutions, consisting of a tank for the prepared chloride solution, a tank for the tannin solution and a tank for water storage, each of which should be of such dimensions as will amply meet the requirements of the plant.

Standard railway tanks will do for a small plant, say for two retorts, but for a larger plant a tank 30 feet in diameter and 20 feet deep, holding something like 100,000 gallons, is about what is most suitable. These may be of wood, iron bound except for creosote, which should be steel throughout.

Seventh—The vats for the preparation of the chloride should be of wood, lead lined, the one for

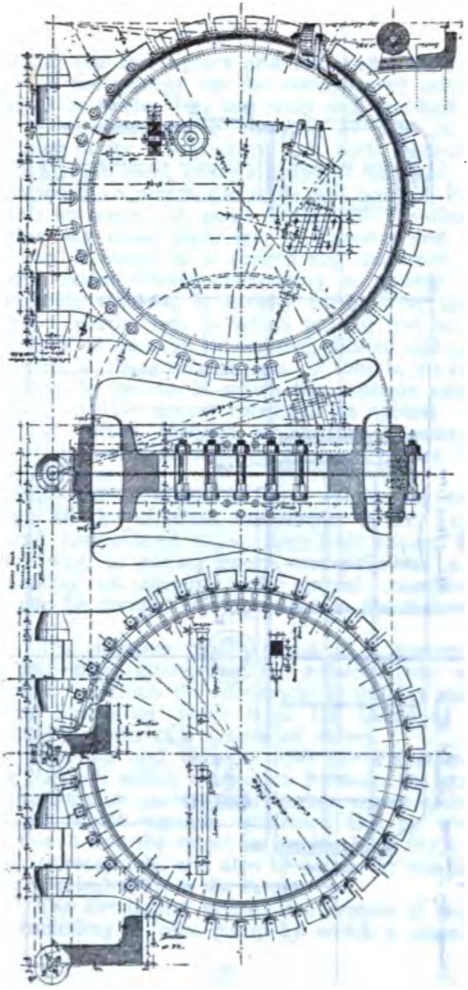

FIG. 5—BOLTED DOOR

dissolving ten feet square and two and a half feet deep, and the storage vat for concentrated solution, say eight by twelve feet and three and one-half feet deep. The concentrated chloride, as well as the acid used in its manufacture, are both destructive to iron or even steel, hence a lining of half-inch lead is interposed on which the acids will not act, hence will last for years. A small mixing tub for dissolving glue, say about eight feet in diameter and four feet deep, in which it is soaked and dissolved, and to some extent diluted preparatory to mixing with the chloride solution, is usually used. The tannin requires a similar tub, in which four or five barrels of the bark extract can be emptied, diluted and used.

To each of these mixing vats or tubs is provided an ejector, by means of which the contents can be forced up into the proper receptacle as needed. The pipes and valves, through which the concentrated solution is passed, must be of chemically pure lead, as the lining is.

Eighth—The system of iron piping to carry through all the different movements is too extensive and complicated to be described, except in a general way, as almost every case calls for some modification on account of special conditions. They can be divided and described in the following order:

(a) The solution pipes consist of a system of large iron pipes connecting the solution tubs with the retort by which the movement is quickly made, the full control of which is in the hands of the operator by means of a system of valves.

(b) The air and vacuum pipes are a system of piping through which connection between the retort and the vacuum pump and the air compressor is made, by which vacuum is drawn and by which air is forced into the retort in forcing back the solution to its receptacle, and also by which the steam or the air is released from the retort.

(c) The circulating system is a system of minor pipes, including a force pump by which a plentiful

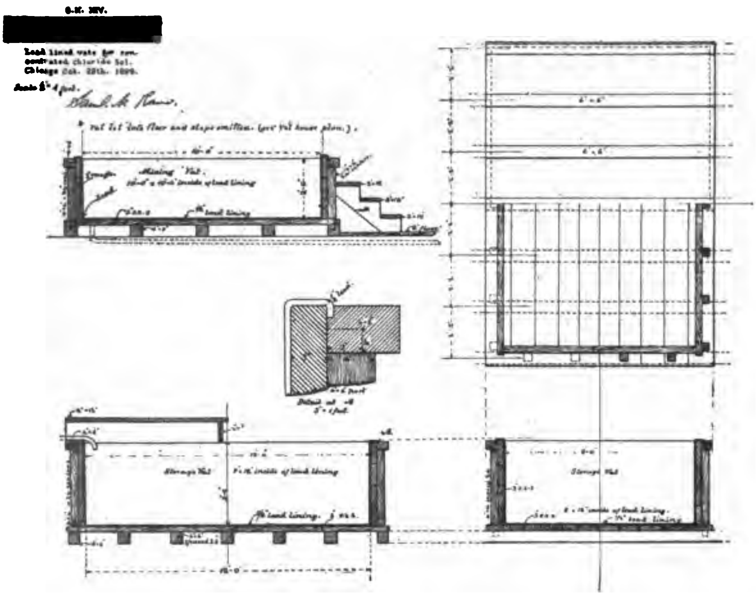

FIG. 7—LEAD LINED VATS.

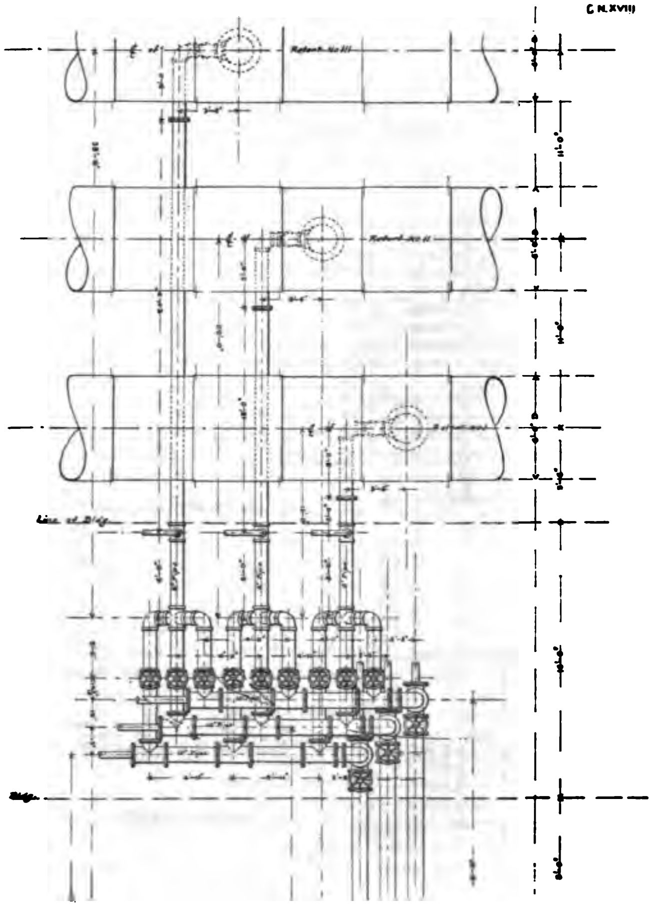

FIG. 8—SOLUTION PIPES (3 MOVEMENT)

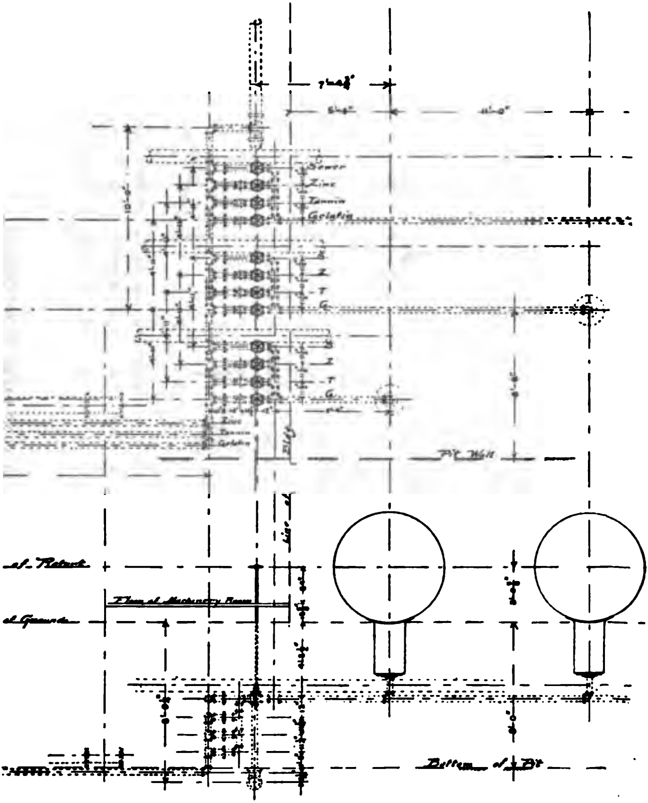

FIG. 9—BLOW-BACK SYSTEM (3 MOVEMENT).

stream of cold water is forced through the surface condenser during production of vacuum, by means of which the steam and vapors from the retort are condensed and cooled before reaching the vacuum pump.

(d) The blow-back system is a set of pipes of minor size by which the last remnant of solution is forced back into its proper receptacle by means of the air compressor continuing its service after the solution valves are closed.

(e) The puddler consists of a system of small pipes connecting between the compressor and the solution tubs, the chloride dissolving vat, the chloride storage vat and the glue and tannin mixing tubs, by which they may be agitated by a stream of air from the compressor.

This is quite important, as it keeps the chemicals in the solution in suspension and aids in rapidly dissolving those in the mixing or dissolving vats.

(f) Steam coils and heating pipes. These consist of steam coils in each of the solution tubs by which the desired temperature is secured to each solution; also such radiators as may be necessary to heat the building, all having steam direct from the steam boilers and discharging all condensations by means of a steam trap to the boiler-feed tank or to any desired hot-water reservoir.

(g) Steam pipes. The steam pipes from the boilers by which steam is furnished to each of the pumps, engines, etc., need not be further noticed here except to say that they should be of ample size and should lead as direct as possible to each machine, and should be well protected against radiation. This should be especially and effectually done with the line conveying steam to the stationary power by which charges are handled, which are located at considerable distance from the boilers.

(h) Suction and discharge pipes of the various pumps need here only be mentioned.

(i) Service and security against fire.

In large plants, a large force pump connecting

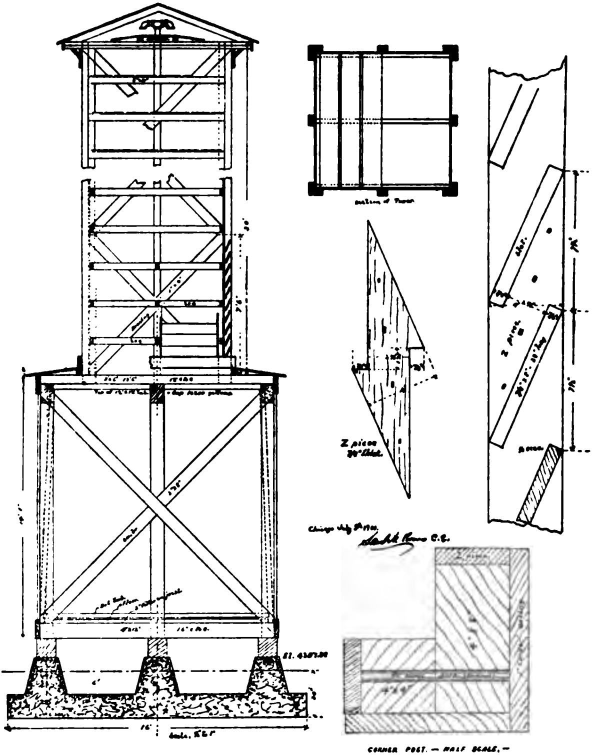

FIG. 9½.

In a case where water is scarce and expensive a cooling tower is used (Fig. 9½) in connection with the circulating system by which the cooling water after passing through the condenser is forced to the top of the tower and then released and allowed to drip back into the tank from which it is drawn. Thus it can be used over and over, little being lost.

with an ample supplv of water in case of fire breaking out, the discharge of which, with its pipes, to the various parts of the works, and sufficient number of hydrants and ample supply of hose, is a very important adjunct. It may be made to do general pumping service, at the same time being always ready for a fire.

(j) Automatic drain from the retort. This is an arrangement of pipes connecting the drain well of the retort to the sewer by which all condensations during the operation of steaming shall be carried to the sewer, thereby keeping the retort as free as possible from water.

It may be arranged to operate automatically by means of a steam trap, or it may be operated by the operator by means of a valve in case the steam trap fails to operate.

All of these systems must be planned and plainly delineated to work together harmoniously, nowhere interfering with each other, and each constructed so as to do its work properly, and the outlines and dimensions put on paper so that the shop men can make every piece and put it in its place.

Ninth—The power required for charging and discharging the retort, and for moving the tram cars in the yard is furnished by a stationary engine. By means of a drum and cables supplemented by fixed snatch pulleys in different positions, the operation can be carried several hundred feet each way. Two and sometimes more of these shifting engines are required in a large plant.

Tenth—Tram-yard tracks. This consists of a system of tram tracks conforming in gauge to the tracks in the retort and extending with switches, cross-overs, etc., such as the dimensions of the works shall require, by which timber is brought from a standard railroad yard or from storage piles and conveyed to and from the retort, and again discharged into piles or loaded on cars for reshipment. While the gauge of these tracks must be the same as that in the retort, yet heavier rails may be used, and 48 to 56 old rails can be utilized.

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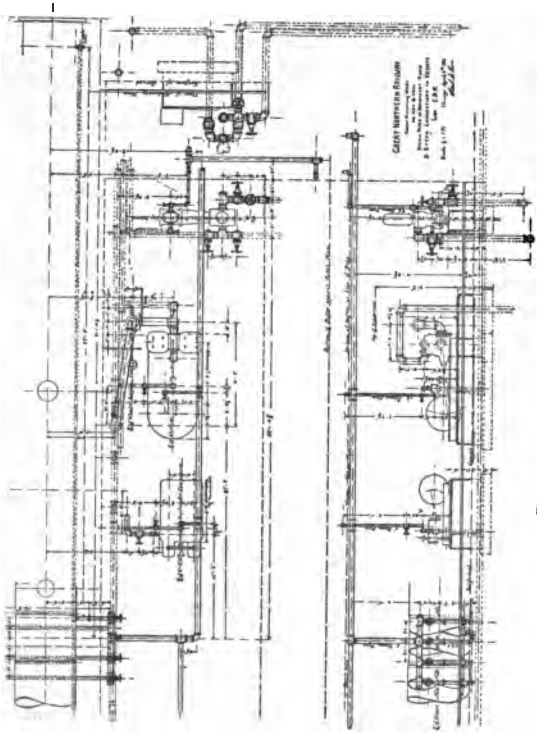


FIG. 10—STEAM PIPING (G. N. RY.).

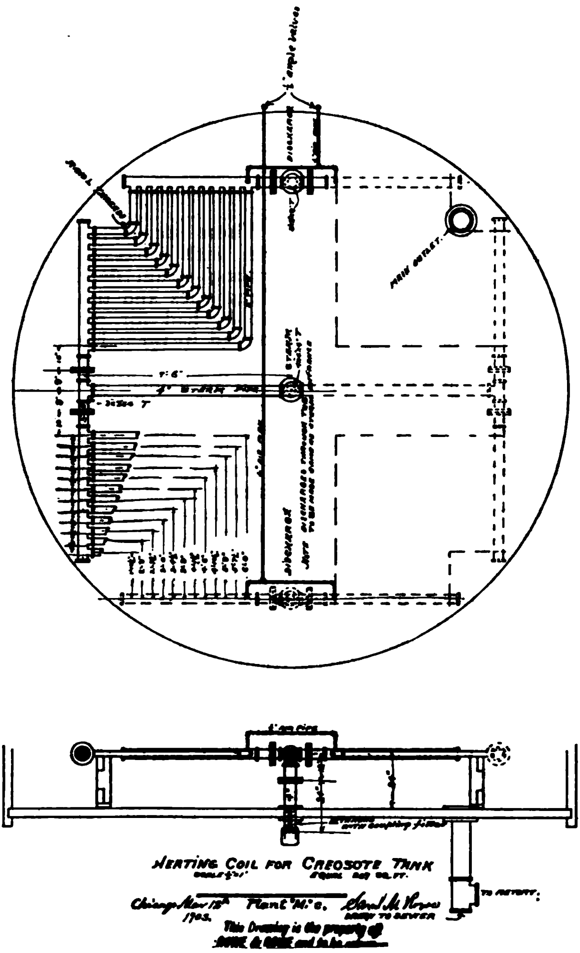


FIG. 11—HEATING COILS FOR CREOSOTE, CHLORIDE AND TANNIN TANK.

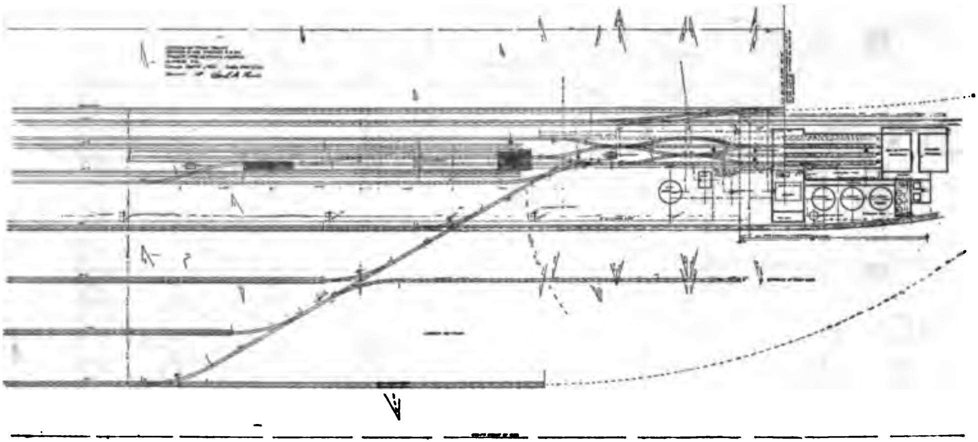


FIG. 13—TRAMWAYS (ALAMOSA YARD).

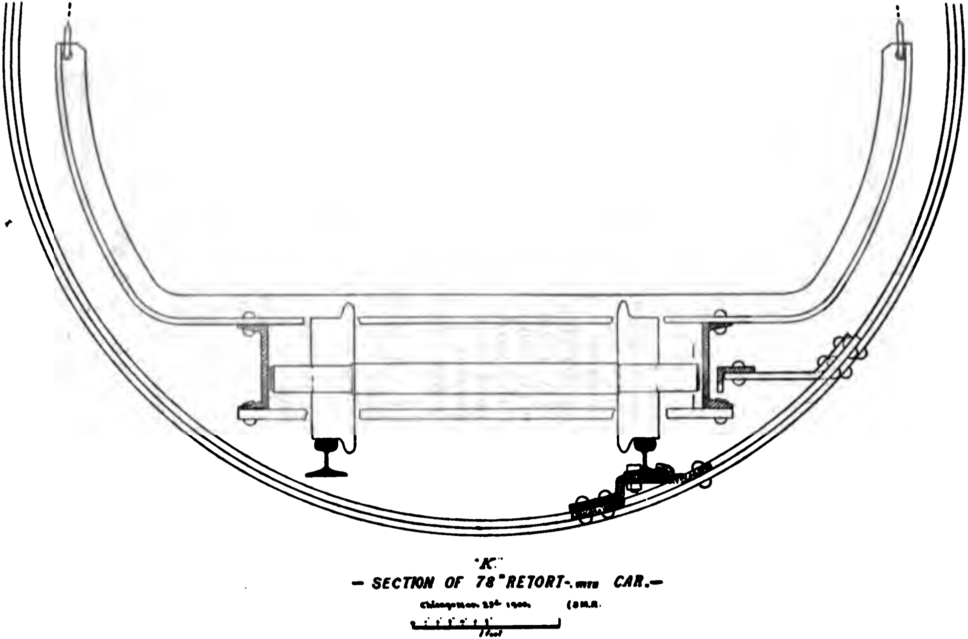


FIG. 14—RETORT SECTION WITH CAR.

ing and again after, whereby knowing the weight and strength of the solution, the amount of the chemical absorbed, can be determined accurately.

Fifteenth—Buildings.

Where a plant is to be operated continuously day and night, and in all climates and kinds of weather, the buildings must necessarily cover and protect the machinery and appliances effectually. Ordinarily, wooden buildings or wood covered with corrugated iron on sides and tar paper, tar and gravel for roof, are found best adapted to the purpose. These can be made to effectually shelter the works, are cheap, and as the plant and its operation are not always permanent, this form of building is best adapted to easy removal, with little loss, if the necessity comes. The buildings particularly required are:

(a) The building covering the retorts.

(b) The machinery room, containing all pumps, valves and machinery, with the exception of the shifting engines in the yard. The machinery must be compactly arranged so as to be under the eye and hand of the operator.

(c) The boiler room containing the boilers, feed pumps, etc.

(d) The chloride vat room.

(e) The storerooms for storage of chemicals.

(f) Blacksmith shop and repairing room.

(g) Office.

(h) Housing for shifting engines.

Sixteenth—Lighting.

A small electric plant is almost indispensable. It may consist of a small steam engine operated by steam from the boilers and a dynamo good for ten arc lights of 1600 c. p. or its equivalent, furnishing four or five lights outside and any desired number of incandescent lights inside.

A PORTABLE PLANT.

A portable plant for timber treating in some cases will be found both convenient and economical. The retort is one of a pair built for the Union

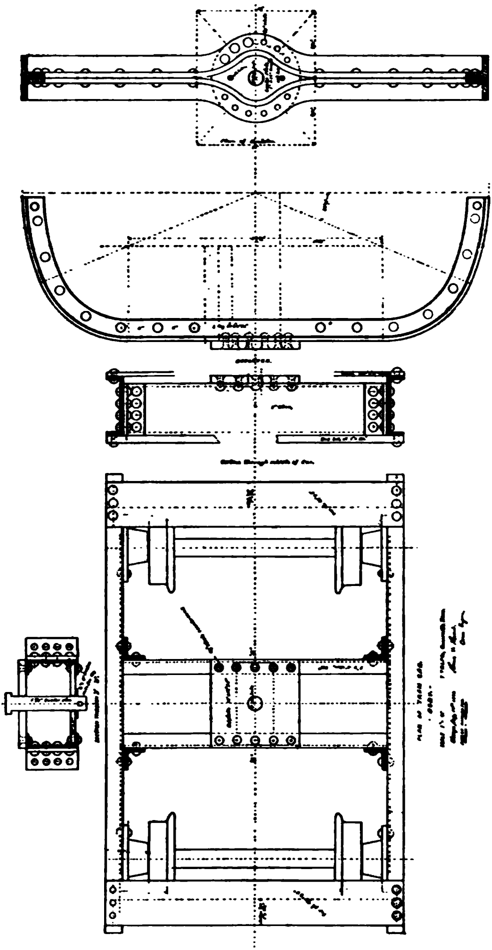


FIG. 15—BOLSTER CAR.

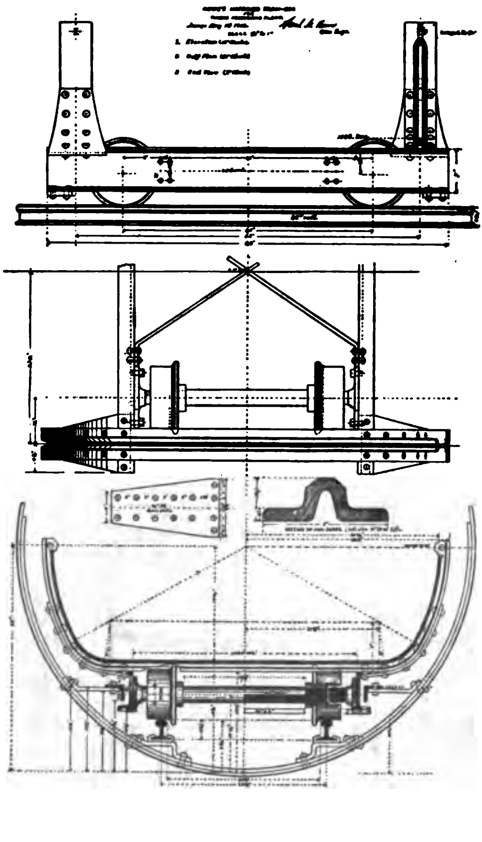


FIG. 16—ROWE'S IMPROVED TRAM CAR (BALL BEARING).

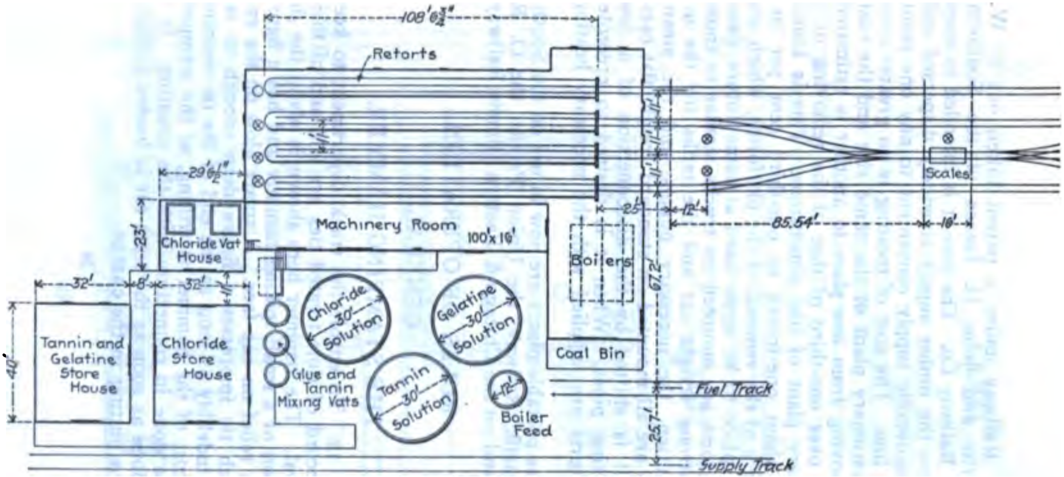


FIG. 17.—GENERAL LAYOUT OF BUILDINGS (G. N. RY.)

Pacific Railway under a patent taken out by W. G. Curtis and John D. Isaacs of the Southern Pacific Railway Co. The case it is intended to meet is where the timber supply is widely dispersed and no considerable supply convenient to any one point on the line. The cost of treating is no greater than at a stationary plant of the same size and the cost of removing from one place to another is estimated at not over one-third of that of the removing of a stationary plant of like dimensions. This is found to be about one-fourth to one-third cent per tie, exclusive of the removal of the platforms, which are left in place to be again used at some future time. The retorts are mounted on trucks similar to those of a strong freight car and the tanks for the oil or solution, the necessary pumps, and the steam boilers are all mounted on standard freight flat cars, and all is shifted by the disconnection of a few connecting pipes. When it is desired to creosote, the retorts are supplied with the necessary heating coils.

Three portable plants are now in use on the Southern Pacific Railway, the Union Pacific, the O. R. & N. and on the Chicago & Eastern Illinois Railway.

RULES OF OPERATION.

GENERAL.

THE STAMPING HAMMER.

Sec. 12. To enable the track department to keep any record of time treated ties are laid and of their removal. The hammer here shown is about the dimension of a small spiking hammer and has a figure cut in relief on one face. A smart blow on the end of each tie impresses a figure deep enough to remain indelibly as long as the end of the tie remains. The cost of the hammer is trifling, as the stamping can be done in connection with the counting. It is best done as soon as the tram car is loaded preparatory to putting in the charge.

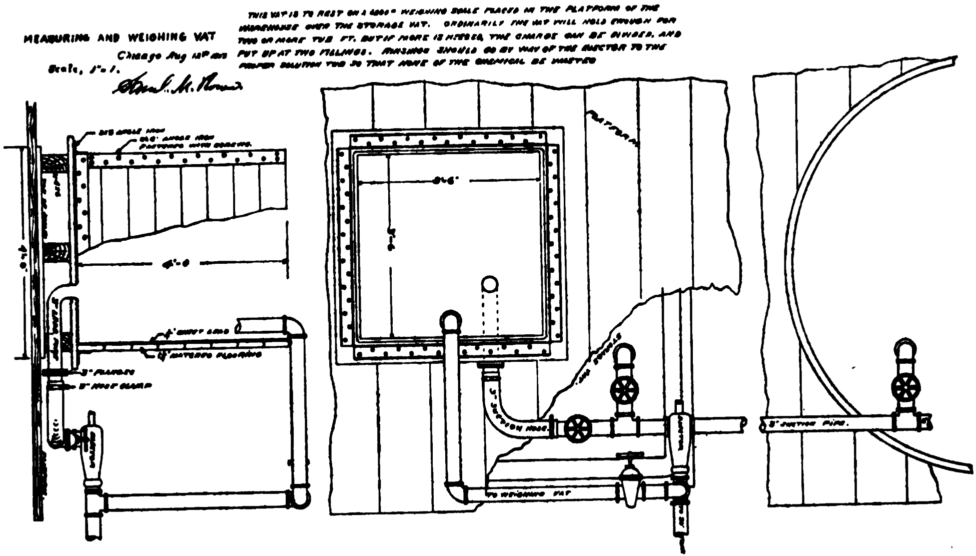


FIG. 18—WEIGHING VAT.

THE DATING NAIL.

The Dating nails here shown, suggested by Octave Chanute, C. E., are intended to be driven into the tie after it has been placed in the track. The best place seems to be on the line side of the track, say 12 inches from the line of the rail. The cost of the nail is approximately 2-10 cent each.

The main purpose of the nail does not preclude the use of the stamping hammer before introducing for treatment, which is considered as well worth doing even if dating nails are to be used.

In operations where the plant consists of one, two or three retorts, it is usual to start the charges about an hour apart, so that the use of compressor and vacuum pump will not interfere and can be applied to each retort in turn; thus all three retorts can be operated by the one machine. If the plant has more than three retorts, say four or six, then a second compressor and vacuum pump will be required, and the retorts can and should be run in pairs.

Each retort requires its own force or pressure pump and its separate system of piping for solution, steam and air, so arranged as to serve each retort in its turn.

The details of operation, more specifically given, are divided about as follows:

(a) Preparing the charge and manner of loading the timber.

As it is essential that the steam and the solution, each in its turn, shall have free access to all sides of the timber (each piece), a space must be left or reserved for this, especially for sawed stuff, otherwise the operation will be greatly impeded or entirely defeated.

A compactly loaded mass of timber will act much as if it were still unsawed. This has been exemplified in the nine-foot retort, where, even with quarter-inch iron strips between, the steaming requires from three to four times as long a time as that required where the pieces are properly separated, and the

XXXIX.

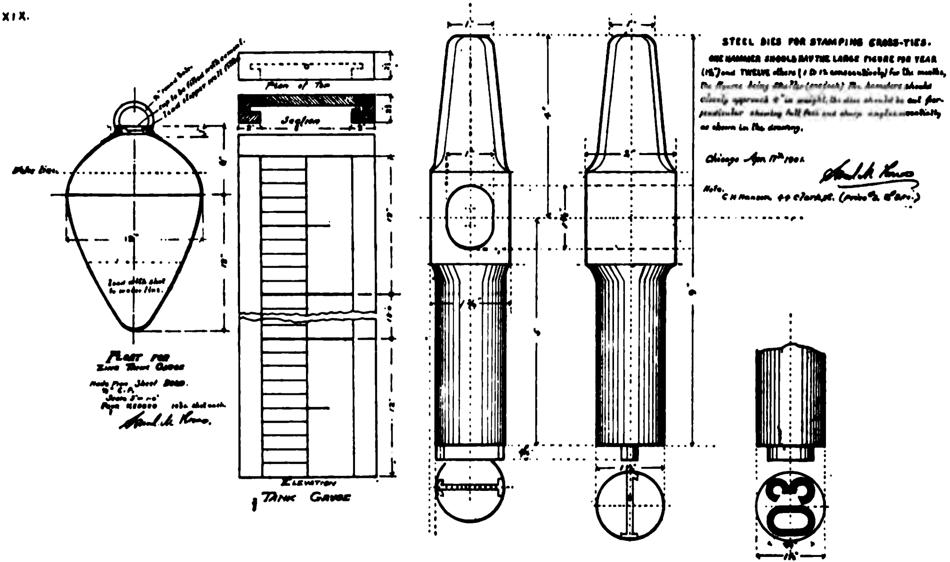


FIG. 19—STAMPING HAMMER INDICATOR, BOARD AND FLOAT.

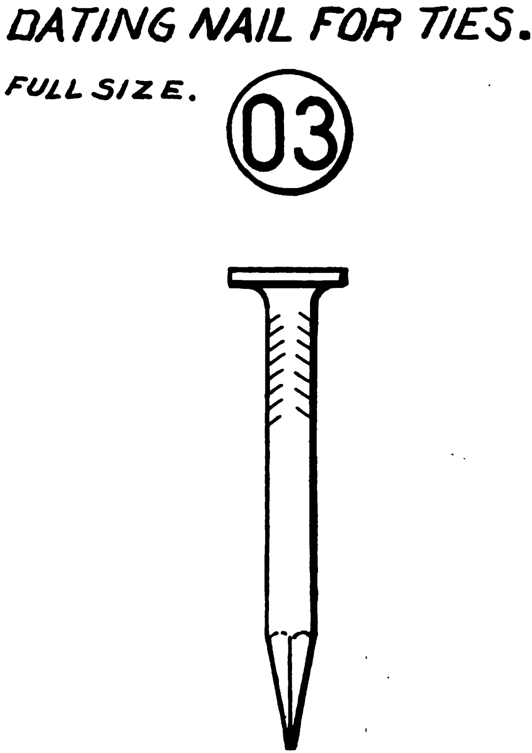


FIG. 20—DATING NAIL.

same is true as to pressure on solution. A one-inch strip, or an ordinary barrel stave, will do with sawed ties. Hewn ties do not need this.

In loading, the ties should be arranged to conform to the loading gauge, so that there will be no interference in charging, and there firmly chained, care being taken to have the load even at the ends so as to allow the inspector easy access for counting and stamping.

The stamping die should be a hammer about the weight of a small railroad spike maul, weighing three and a half to four pounds, with handle similar and with the die full faced and deeply cut (three-eighth inch), vertical and not tapering, securing an impression deep enough to last as long as the timber itself.

The loaded cars are then assembled to make the proper charge, and are then, by means of the shifting engine, cables and pulleys, drawn into the retort, the doors closed and sealed, when all is ready for:

(b) Steaming.

The steam is introduced into the retort, preferably at each end and nearly at the bottom. Meanwhile the blow-off at the top of the retort is kept open to allow the air to escape until the retort is full of steam. When the retort is entirely filled, the blow-off is closed and the steam is accumulated until it has reached a pressure of twenty pounds per square inch and there held throughout the entire remaining time required—four to six hours. This pressure is fixed as the maximum, as the temperature of the steam is then at near 250 degrees Fah., about all that the timber will bear without scorching and injury to its fiber. Frequently during the steaming, the condensations should be drawn off from the retort, by means of the automatic blow-off, to the sewer, accelerating the dryness of the steam and reducing condensation, and securing greater dryness in the timber after the vacuum is drawn. The steam is then blown off, being discharged into the air.

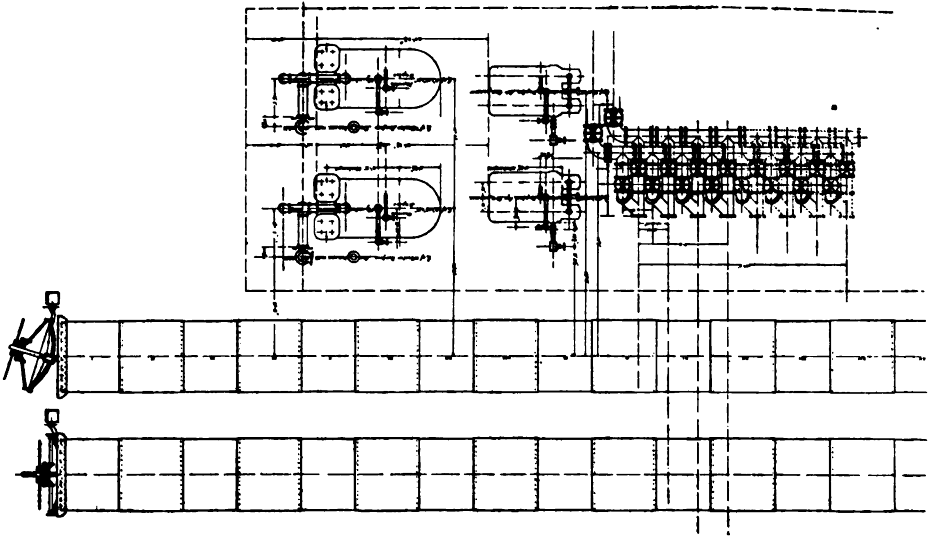


FIG. 21—SOLUTION PIPES (TENTATIVE PLAN 8 RETORT WORKS).

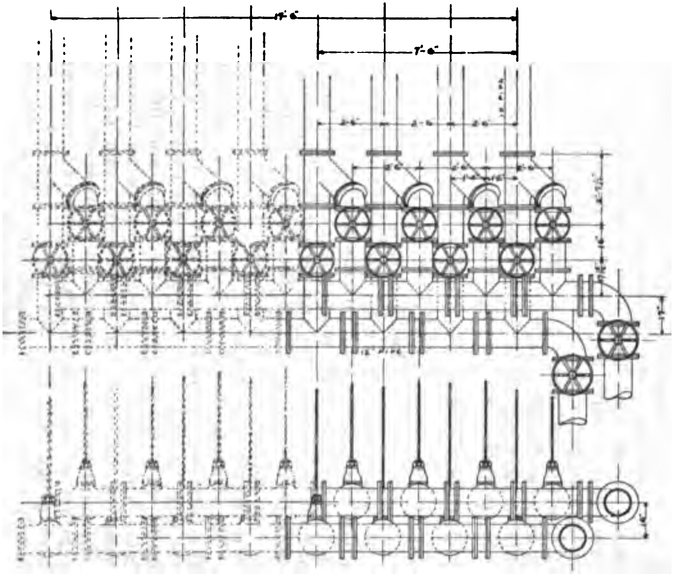


FIG. 22—SOLUTION PIPES AND VALVES (8 RETORT WORKS).

SUPERHEATED STEAM IN CONNECTION WITH TIMBER TREATMENT.

There can be no doubt as to the utility and economy in the use of superheated steam for heating the solution or oils used where the steam is used in coils, as it expedites the process and saves in fuel. It is, however, very questionable whether superheated steam can safely be used where it comes in direct contact with the timber, as during the period of steaming, as the temperature is more difficult to control, endangering the timber fibre as is not possible with saturated steam at the prescribed pressure of twenty pounds. It has been observed, where it is so used, that the timber is often burned.

TEMPERATURE IN THE VARIOUS SOLUTIONS.

(Thermometers.)

It is generally conceded that the temperature at which the various solutions are applied is important in that a quite high temperature conduces to more prompt chemical action and perfect combination. To more perfectly control this, the Fahrenheit thermometer is applied both to the retorts and to the solution reservoirs or tanks.

The drawing herewith shows the usual method of attaching the thermometer to the retorts. There is no way by which more perfect connection can be made with the contents of the retort and the indicated temperature will be somewhat below the actual mean of the reservoirs until after long exposure. The most important function is to measure the temperature of solution or oils as with the steam pressure gauge will give the heat of the steam sufficiently close. A few observations will give the correction to be added, approximately at least. In any case the approximate will be a fair guide in absence of any means of obtaining exact readings.

(c) The vacuum.

When the steam is fully blown off the retort

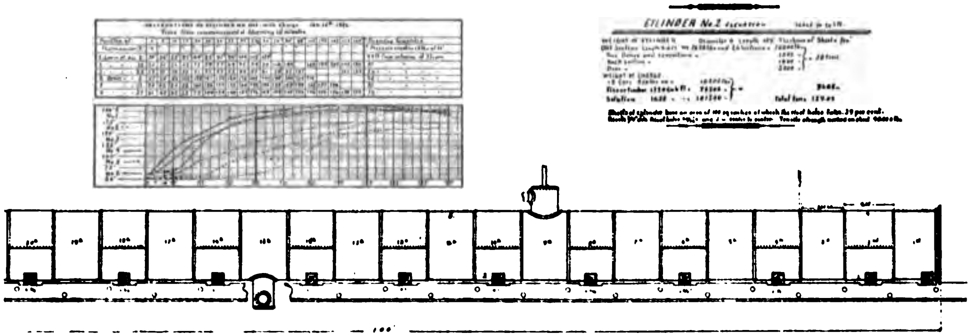


FIG. 23—RETORT NO. 2 (LAS VEGAS).

Showing how entrance of steam at the top of the retort expanded, the stud plates causing rupture of the sheets at the bottom. The diagrams indicate the temperature of the sheet at six different points during the steaming of the charge.

should be allowed to cool for a little time, the circulating water should be started through the surface condenser and allowed to flow, insuring the greatest degree of cold surface to the hot vapors from the retort before the vacuum pump is started, thus preventing these hot vapors from injuring the valves of the pump.

In a one or two retort plant, one of the force pumps can be utilized for pumping the circulating water; but in a large plant, either the service and fire pump will answer, or a special pump will be necessary.

Thus having cooled the condenser, the vacuum is drawn, raising it as fast as is practicable to 20 at 26 inches, and there holding it for half an hour or more, if desired. If the hot-well catching the condensation fills so that the contents are thrown off through the vacuum pump, and it is desired to measure it, resort must be had to an auxiliary reservoir, so arranged as to receive the surplus when necessary. The practicability of measuring these condensations with a view to determine the amount of sap extracted from the timber, is a matter of doubt, and will be noticed further on.

A marked advantage has been secured in treating obdurate timber (dense, wet or green), by interposing a vacuum at an intermediate time during the steaming, blowing off the latter, drawing a vacuum and again introducing the steam while the vacuum is still held. This idea is worth investigating when opportunity offers.

(d) Introducing the chloride solution.

The vacuum having been on for sufficient time, it is still held, and the valve in the solution pipe is opened and the solution allowed to flow in, which it does very rapidly by the help of the vacuum, until the retort is entirely filled, the air pipe being opened to allow the escape of the remaining air in the retort and then closed.

The solution should be heated from 80 to 100 degrees Fah. before introduced, as it is found that the

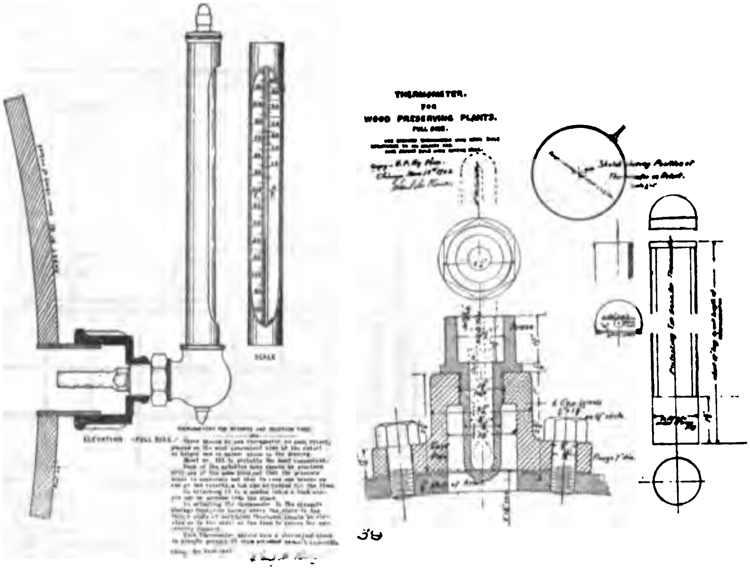


FIG. 25—THERMOMETERS, SHOWING METHOD OF ATTACHMENT.

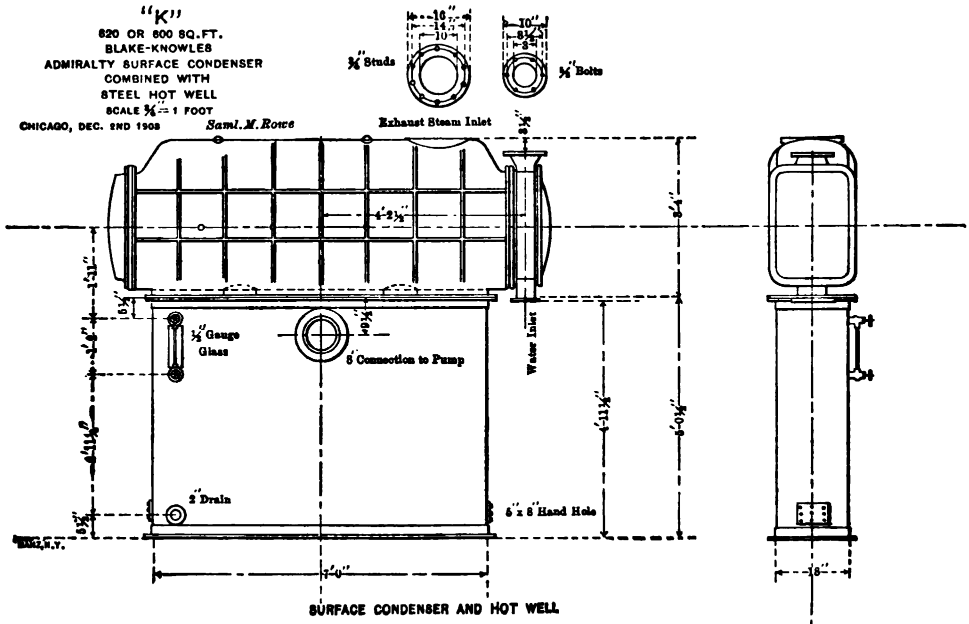


FIG. 26—CONDENSER AND HOT-WELL.

chloride is held best in suspension at about that temperature.

When the retort is filled and the air pipe closed, the force or pressure pump is at once started and the pressure raised to 100 pounds per square inch, which should be done in a very short time, and there held for such time as shall be judged best to meet the nature of the timber.

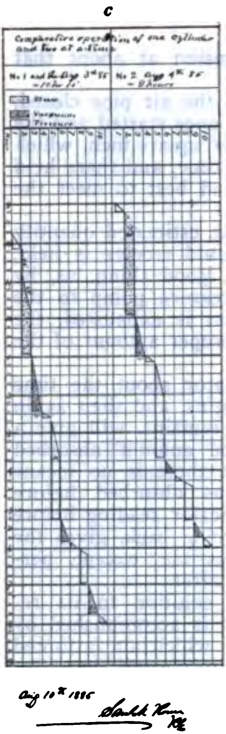
A measuring vat, in which the estimated quantity of solution that the charge should receive is held, is recommended by some as a good thing, as, by attaching the suction of the pressure pump to the vat and running it until the vat is exhausted, the timber will have absorbed the proper amount of the solution.

Careful reading of the indicator about the time the pressure from the pump begins, and then again at times during which pressure remains, will give a very close measurement of the amount absorbed during that time, but of course there is no means of determining how much was absorbed before pressure was secured. The indicator reading before introducing and again after forcing back, gives the most accurate measurement possible, except, perhaps, the weighing before and after.

(e) Returning the chloride solution to its receptacle is the next move, and is accomplished by means of the air compressor by which air is forced into the retort. When it is quite cleared the valve in the main solution pipe is closed, and the blow-back is used to clear the retort of the last remnant of solution, which is carried to its proper tub by an overhead pipe.

(f) Introduction of the tannin solution.

As soon as the chloride solution has been cleared from the retort, the tannin solution is introduced, put under pressure and so held for the desired period, and forced back to its receptacle in every respect as with the chloride, except that the time held under the pressure of 100 pounds need not be so long, as the action of the tannin is quite superficial.



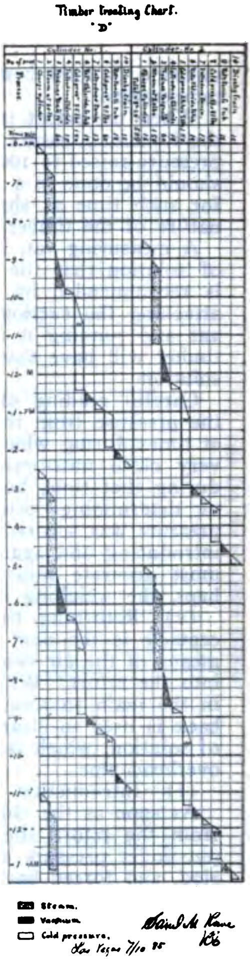


FIG. 27—ORIGINAL DIAGRAM OF RUNS (LAS VEGAS, 1885).

This completes the operation. The doors being opened, the charge is removed from the retort. The next charge being prepared is run in, the doors are closed, and the whole program is repeated. A charge takes from 10 to 12 hours.

RULES FOR MIXING CHEMICALS.

ZINC-TANNIN OR WELLHOUSE PROCESS.

CHEMICALS USED.

Chloride of Zinc. (Zncl₂.)

Sec. 13. The principal antiseptic agent used in this process is the chloride of zinc. The chloride can be made on the ground by the combination of hydrochloric acid (muriatic) with common metallic zinc, or the commercial product in the form of a salt furnished in large drums or rolls protected by a covering of thin sheet iron. There is but little difference in the cost, the difference being in favor of the commercial article.

Empirically, the hydrochloric acid (Hcl_2) and the zinc spelter (Zn) combines about as follows: 350 lbs., 18 per cent acid to 100 lbs. of the spelter will produce 409 lbs. of 45 per cent $Zncl_2$, equal to about 185 lbs. pure chloride of zinc.

With acid at 1½ cents and zinc at 5 6-10 cents would be 5 87-100 cents per lb. pure chloride of zinc. The fused chloride, 98 per cent pure, is now sold for four cents, so that at the above price for the acid and the spelter it is better to use the fused chloride, at considerable saving in freight as well as in the convenience in its use.

(c) The commercial chloride being most readily obtained and more convenient to use, is being generally used, hence, in the rules here given, the commercial chloride will be understood.

(d) The impurities in the salt should not exceed three per cent in weight, and are, with one exception, quite harmless, except as an impurity. The presence of a small amount of iron, however, say one-half of one per cent, should condemn it, as the

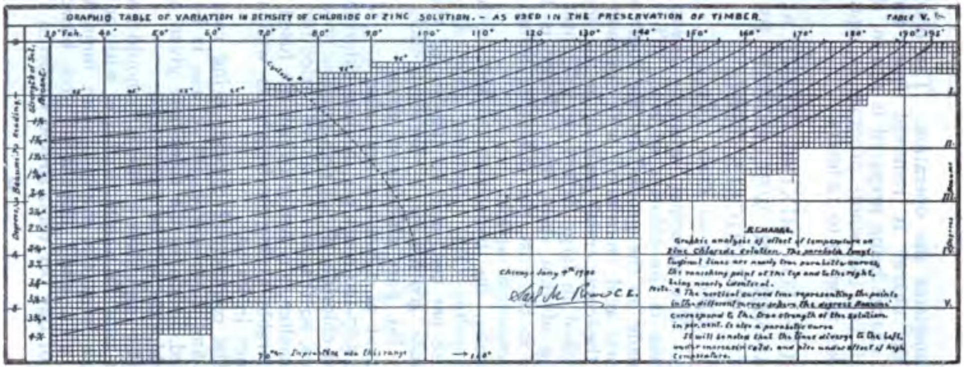


FIG. 28—GRAPHIC TABLE, DENSITY OF CHLORIDE OF ZINC.

iron neutralizes the chloride and at the same time is said to injure the wood fiber.

(e) The commercial salt will often have a small amount of free, uncombined acid, which is destructive to wood fiber if present in any great amount, hence the dissolving as well as the storage vat should contain a liberal allowance of the zinc blocks to take it up, and the time allowed for its action should be as extended as possible.

(f) A graphic table of weight and specific gravity of chloride of zinc is here given, which gives the data on which the table for quantities, in Table "B," is computed. While it is not claimed to be exact, yet it gives a sufficiently close approximation and serves the purpose. It is the summing up of numerous trials.

PREPARATION OF CHEMICALS FOR USE.

Sec. 14. The chloride of zinc.

(a) Dissolving: The fused chloride (commercial) should be dissolved into stock solution, a concentrated solution from 35 to 50 per cent strong, some little time before used, say 24 hours if practicable, so that it shall be thoroughly dissolved, and that any free acid it may contain will have time to be taken up by the spelter (zinc) kept in the dissolving vat for that purpose.

The drums or rolls of fused chloride should then be divested of the iron covering, weighed, and if the works are provided with a trolley carrier, be placed bodily in the dissolving vat. or in absence of the trolley, they should be broken into smaller fragments and dropped from planks placed over the vat, which should have been previously partially filled with water. In placing the pieces in the vat, care must be taken that the lead lining of the vat be not injured.

(b) The following will guide as to the amount of the salt to be weighed in, and as to the amount of water for dissolving. First fill vat about half

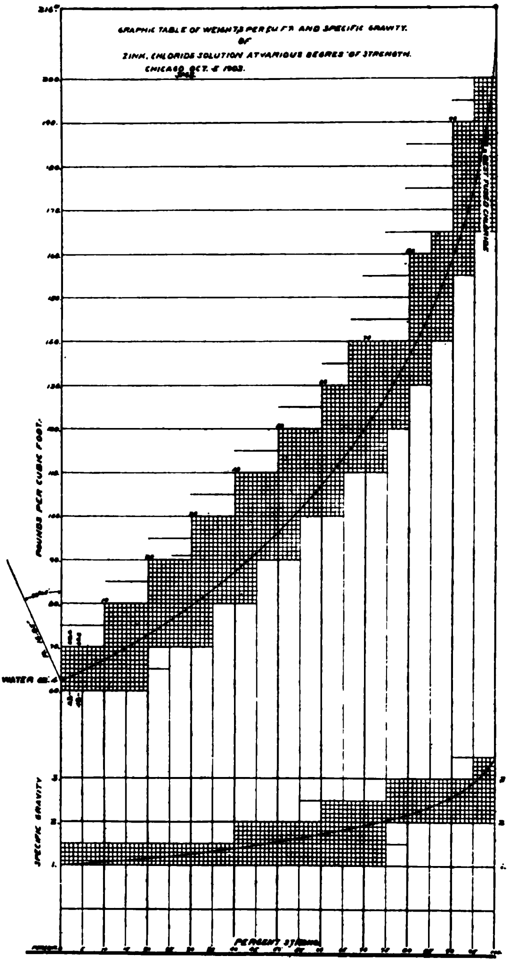


FIG. 29—GRAPHIC TABLE, WEIGHT OF CHLORIDE OF ZINC.

full, and then add the chloride and fill with water to the height indicated:

For 35 per cent stock solution—

6,296 pounds salt, and fill to 2.2 vertical feet.

For 40 per cent—

7,865 pounds salt, and fill to 2.3 vertical feet.

For 45 per cent—

9,285 pounds salt, and fill to 2.3 vertical feet.

For 50 per cent—

10,860 pounds salt, and fill to 2.3 vertical feet.

(c) This computation is based upon a mixing vat ten feet square and two and one-half feet deep, and, being lead lined with half-inch sheet lead, has approximately an area of 99.4 square feet.

The above is a fair guide, remembering that the exact amount of the salt or the resulting strength of solution is not essential, as any intermediate strength can be used by the same means of computation.

A solution of from 40 to 50 per cent is about the most convenient.

(d) When this stock solution is well neutralized and dissolved, it is drawn off into the storage vat, a lead-lined vat the same as the mixing vat, except in dimensions. This vat is provided with a steam ejector by which the concentrated stock solution is forced into the solution tub or tank through a discharge pipe passing over the top and there discharging.

PREPARATION OF DILUTED TUB SOLUTION.

Sec. 15. (a) Assuming the size of the storage vat to be 8 by 12 feet, area being 96 feet, and the solution tub being 30 feet in diameter, wood and iron bound, with a mean area of 664 square feet, then we have for putting up the stock chloride from storage vat to the diluted solution tub, Table "B," giving the number of cubic feet of stock solution for each tub foot required, hence by multiplying this by the number of tub feet to be charged, and dividing the

result by the area of the storage vat (96 sq. ft.), gives the vertical feet to put up.

Dilution of Chloride Solution.

(b) To make up the first tub of solution, say two per cent strong, fill solution tub with water to, say 17 feet, the tub being 20 feet deep, each tub foot being equal to 664 cubic feet (mean area of tub) by 17 vertical feet, equal 11,288 cu, ft. multiplied by 62.3 lbs. (weight of cu. ft. of water) equals 703,242 lbs. water.

Then as 98 per cent of water is to the two per cent of chloride, so is 703,242 lbs. of water to 14,352 lbs. pure chloride required.

Then for cubic feet in volume of the two per cent chloride we have: Water, 703,242 lbs., which divide by 62.3 lbs. equals 11,288 cu. ft., and chloride, 14,352 lbs., which divide by 200.0 lbs., equals 71.76, making total of 11,359.76 cubic feet, or about 17.2 vertical or tub feet.

DETERMINING STRENGTH OF CHLORIDE SOLUTION.

(c) No more satisfactory means have been found for testing the strength of the chloride solution than the Beaumé Hydrometer, using the coarse hydrometer, one to sixty degrees for the concentrated and the fine hydrometer, one to six degrees, divided to 1-10th degree, for the highly diluted solutions. In the heavier solutions, say 30 to 60 degrees, the influence of temperature is small, so that no account need be made for it, but with that highly diluted it is necessary to define the effect of temperature very carefully to get true measurement of strength.

To meet this, the table (A), Figs. 32, 33 and 34, has been prepared by means of empiric tests subjected to a law of curve developed by trial, by which a close approximation has been made. Comparison of calculated quantities used in one month's run, with the actual quantity of stock used, has served to confirm the exactness of the tables.

Figs. 30 and 31 give the same graphically, the curves described being true spirals both as to the variation under increased heat and for the points at which the per cent of strength agrees with the degrees Beaumé.

The use of the hydrometer is impracticable with the glue and the tannin solution, either being about the same specific gravity as water.

WATER FOR DILUTION.

Sec. 16. It is here proper to notice the character of the water to be used in this connection in making up the chloride solution.

In carrying through the process, a considerable quantity of water, variously estimated at 15 to 25 thousand gallons per day per retort, including the supply for steam and circulating purposes as well, is used. Pure water is very desirable and its quantity is important, for, should it be bounteous, much may be saved in water saving appliances. There are some locations where it is desirable to locate works that the quantity is meager and the quality is poor.

GELATINE (Glue).

Sec. 17. Commercial glue of good quality contains the gelatine which, under the Wellhouse process, forms a part of the plugging up substance by its combination with the tannin. Glues vary considerably in the amount of gelatine contained, but 60 per cent is supposed to be a fair estimate for a good commercial article.

(a) The per cent in weight of water at 60 degrees Fah. that any glue will absorb, is said to be about the best test of quality. A first-class glue, it is said, will absorb 13 parts of water to 1 of glue, but it is found that some of the best cabinet glues will not take over 5 or 6 in the 24 hours' test.

(b) It has been, and now is, the practice to use a solution in combination with the chloride consisting of one-half of one per cent of the total in glue.

FAH. THER. READING.

Sig. Bat.	70°	1	2	3	4	5	6	7	8	9	80°	1	2	3	4	5	6	7	8	9	90° F.
1%	1.11	1.10	1.09	1.08	1.06	1.04	1.02	1.01	0.99	0.97	0.96	0.93	0.91	0.89	0.88	0.86	0.83	0.81	0.79	0.77	0.75
1¼"	1.41	1.40	1.39	1.37	1.36	1.35	1.34	1.32	1.29	1.27	1.25	1.22	1.21	1.19	1.17	1.15	1.13	1.11	1.09	1.07	1.05
1½"	1.78	1.70	1.69	1.67	1.65	1.63	1.61	1.60	1.58	1.56	1.54	1.52	1.50	1.48	1.46	1.45	1.43	1.41	1.39	1.37	1.36
1¾"	2.01	2.00	1.99	1.97	1.94	1.93	1.91	1.90	1.88	1.86	1.84	1.82	1.81	1.79	1.76	1.74	1.72	1.71	1.69	1.67	1.65
2%	2.31	2.30	2.29	2.27	2.24	2.23	2.21	2.20	2.18	2.16	2.14	2.12	2.10	2.09	2.07	2.05	2.02	2.01	1.99	1.97	1.95
2¼"	2.61	2.60	2.58	2.56	2.54	2.52	2.50	2.49	2.47	2.45	2.43	2.41	2.39	2.38	2.36	2.34	2.32	2.30	2.28	2.26	2.24
2½"	2.91	2.90	2.88	2.86	2.84	2.82	2.80	2.78	2.76	2.74	2.72	2.71	2.69	2.67	2.65	2.63	2.61	2.59	2.57	2.55	2.52
2¾"	3.21	3.20	3.18	3.16	3.13	3.11	3.09	3.07	3.06	3.04	3.02	3.00	2.98	2.96	2.94	2.92	2.90	2.88	2.86	2.83	2.81
3%	3.50	3.49	3.47	3.45	3.43	3.41	3.39	3.37	3.35	3.33	3.31	3.29	3.27	3.25	3.23	3.21	3.19	3.17	3.15	3.12	3.10
3¼"	3.81	3.79	3.76	3.74	3.72	3.70	3.68	3.66	2.64	3.62	3.60	3.58	3.56	3.53	3.51	3.49	3.47	3.45	3.43	3.41	3.39
3½"	4.10	4.08	4.05	4.03	4.01	3.99	3.97	3.95	3.93	3.90	3.88	3.86	3.84	3.81	3.79	3.77	3.75	3.73	3.70	3.68	3.66
3¾"	4.40	4.37	4.35	4.33	4.31	4.28	4.26	4.23	4.21	4.19	4.17	4.15	4.12	4.10	4.07	4.05	4.03	4.01	3.98	3.96	3.93
4%	4.69	4.66	4.64	4.62	4.60	4.59	4.55	4.52	4.50	4.48	4.45	4.43	4.40	4.38	4.36	4.33	4.31	4.29	4.26	4.24	4.21

HYDROMETRIC READING.

TABLE, I. Temp for each Deg. from 70° to 90° and one to 4% strength

Notice. These tables are compiled from the results of long and careful investigations and study by the author therefore all rights are reserved and copyright will be applied for

At Chicago Aug 4th 1900.

Attest W. W. Bell

Saml M Rowe for Rowe & Rowe.

FIG. 32—TABLE "A" NO. 1.

Fahrenheit Ther. Reading.

Str. Sol. Per. ct.	90°	1	2	3	4	5	6	7	8	9	100°	1	2	3	4	5	6	7	8	9	110° F.
1%	0.75	0.72	0.70	0.67	0.65	0.62	0.60	0.57	0.54	0.51	0.49	0.46	0.43	0.40	0.37	0.34	0.31	0.28	0.23	0.21	0.18
1¼%	1.05	1.02	1.00	0.97	0.95	0.92	0.90	0.87	0.84	0.82	0.80	0.77	0.74	0.71	0.68	0.65	0.62	0.59	0.56	0.53	0.50
1½%	1.35	1.32	1.30	1.27	1.25	1.23	1.20	1.18	1.15	1.12	1.10	1.08	1.05	1.02	0.99	0.96	0.94	0.91	0.87	0.85	0.82
1¾%	1.65	1.62	1.60	1.58	1.56	1.53	1.51	1.48	1.45	1.43	1.40	1.38	1.36	1.34	1.31	1.28	1.25	1.22	1.19	1.17	1.14
2%	1.95	1.92	1.90	1.88	1.86	1.84	1.81	1.79	1.76	1.74	1.72	1.70	1.67	1.65	1.62	1.60	1.57	1.54	1.52	1.49	1.46
2¼%	2.24	2.21	2.19	2.17	2.15	2.13	2.10	2.08	2.05	2.03	2.01	1.99	1.96	1.94	1.91	1.89	1.86	1.83	1.80	1.78	1.76
2½%	2.52	2.50	2.48	2.46	2.44	2.42	2.39	2.37	2.34	2.32	2.30	2.28	2.26	2.23	2.20	2.18	2.15	2.12	2.10	2.08	2.05
2¾%	2.81	2.80	2.78	2.76	2.72	2.71	2.69	2.67	2.64	2.62	2.60	2.57	2.55	2.52	2.50	2.48	2.46	2.42	2.38	2.37	2.35
3%	3.10	3.09	3.07	3.04	3.01	3.00	2.98	2.96	2.93	2.91	2.89	2.86	2.84	2.81	2.79	2.77	2.74	2.71	2.69	2.67	2.66
3¼%	3.38	3.36	3.34	3.31	3.29	3.27	3.25	3.23	2.20	3.18	3.15	3.12	3.10	3.07	3.05	3.03	3.00	2.97	2.95	2.93	2.91
3½%	3.66	3.64	3.61	3.58	3.56	3.54	3.52	3.49	3.46	3.44	3.41	3.39	3.37	3.34	3.32	3.29	3.27	3.24	3.21	3.19	3.17
3¾%	3.93	3.91	3.89	3.86	3.83	3.81	3.79	3.76	3.73	3.71	3.69	3.66	3.64	3.60	3.58	3.56	3.53	3.50	3.48	3.45	3.43
4%	4.21	4.19	4.16	4.13	4.11	4.09	4.07	4.03	4.00	3.98	3.96	3.93	3.90	3.87	3.85	3.82	3.80	3.77	3.74	3.71	3.69

HYDROMETRIC READING

TABLE, II. - from 90°F to 110. For each Deg.

DIRECTION. Take average sample of solution, take temperature and hydrometric reading, then find the latter under the former, and the column of streng at the left of the table will give the true strength.

FIG. 33—TABLE "A" NO. 2.

TABLE III - 30° to 70°F　　Fahrenheit Ther. Reading　　TABLE IV. - 110 to 195°F

HYDROMETRIC READING.

Str. Sol. Per ct	30°	35°	40°	45°	50°	55°	60°	65°	70°	Str. Sol. Pr. ct.	110°	115°	120°	125°	1.30°	135°	140°	145°	150°	175°	195°
1%	1.50	1.47	1.42	1.39	1.35	1.30	1.25	1.19	1.11	1%	0.18	0.14	0.00								
1¼	1.84	1.81	1.75	1.71	1.66	1.61	1.56	1.49	1.41	1¼	0.50	0.32	0.13	0.00							
1½	2.18	2.15	2.08	2.03	1.98	1.92	1.86	1.79	1.71	1½	0.82	0.67	0.49	0.30	0.08	0.00					
1¾	2.52	2.49	2.41	2.35	2.29	2.24	2.17	2.10	2.01	1¾	1.14	0.95	0.81	0.61	0.41	0.18	0.00				
2%	2.86	2.80	2.74	2.69	2.61	2.55	2.48	2.40	2.31	2%	1.46	1.31	1.16	0.99	0.80	0.60	0.39	0.13	0.00		
2¼	3.20	3.14	3.06	3.00	2.92	2.86	2.79	2.70	2.61	2¼	1.76	1.61	1.46	1.29	1.12	0.92	0.72	0.52	0.29	0.00	
2½	3.54	3.48	3.38	3.32	3.24	3.17	3.09	3.00	2.91	2½	2.05	1.90	1.77	1.60	1.43	1.25	1.07	0.82	062	0.00	
2¾	3.88	3.82	3.70	3.64	3.56	3.48	3.40	3.31	3.21	2¾	2.35	2.20	2.07	1.90	1.75	1.57	1.38	1.17	0.95	0.00	
3%	4.18	4.10	4.03	3.95	3.87	3.79	3.70	3.60	3.50	3%	2.66	2.50	2.35	2.21	2.07	1.90	1.71	1.52	1.32	0.00	
3¼	4.52	4.44	4.35	4.27	4.18	4.10	4.01	3.90	2.81	3¼	2.91	2.76	2.62	2.54	2.33	2.16	1.98	1.79	1.59	0.35	0.00
3½	4.86	4.78	4.67	4.59	4.50	4.41	4.31	4.20	4.10	3½	3.17	3.02	2.87	2.78	2.58	2.42	2.24	2.06	1.86	0.75	0.00
3¾	5.20	5.12	4.99	4.91	4.81	4.73	4.61	4.50	4.40	3¾	3.43	3.29	3.14	3.08	2.84	2.68	2.51	2.33	2.15	0.97	0.00
4%	5.57	5.43	5.32	5.22	5.12	5.02	4.90	4.80	4.69	4%	3.69	3.63	3.49	3.28	3.10	2.94	2.78	2.60	2.40	1.28	0.05

FIG. 34—TABLE "A" NO. 3.

The tannin solution, containing the same amount of tannin extract which will combine in about equal parts, forming with the glue the leathery substance in the wood pores.

(c) The specific gravity of a fair glue should be, when perfectly dry, about 1.42, and should readily take six times its weight of water when immersed in it at 60 degrees Fah. for 24 hours.

To determine the specific gravity of any samole of glue, take a graduated tube, say a 200 c. cm. measure. First put in 100 c. cm. water, then weigh out one ounce of the dry glue and drop it into the tube, noting, immediately, the point to which the water is raised by the addition of the glue. The difference in the height of the water in the tube before and after adding the glue, will be the volume of the one ounce of glue in cubic centimeters, from which its weight and specific gravity can at once be computed.

(d) Then to determine the amount of water it will absorb, add to the above another 100 c. cm. of water, place it in a place where the temperature is constant at 60 degrees Fah. for 24 hours, when the proportion of water unabsorbed will appear clearly to the eye. Note this in c. cm. and divide by the whole 200 c. cm. of water, thus determining the proportion absorbed.

(e) In a one-half of one per cent solution of glue, the specific gravity will be inappreciably greater than pure water, so that the only means of determining its strength is to carefully weigh in the dry glue whenever the solution is renewed, the quantity of glue being always the one-half of one per cent by weight of water charged with the glue, and computed in the same ways as for the chloride solution.

(f) It is usual, on account of impurities in the glue, to discount these by putting in an excess, say where 100 pounds of tannin is called for, use 110 pounds of glue. While it is understood that the glue and the tannin combine in about equal quanti-

ties, yet it is safe to have a slight excess of the former, for the reason that if glue should be entirely or even partially absent there would be no action by the tannin, and it would go back into the solution tub as strong as before used. In any case, if sufficient glue is not present, full action of the tannin cannot be expected.

To determine the relative value of glues offered for use in the Wellhouse or Zinc Tannin process:

(g) First prepare a four per cent solution of hemlock extract of known strength (25 per cent to 27 per cent), by putting one ounce of extract into twelve ounces of pure water. Then treat one ounce of the prepared glue, making this also four per cent strong. The glue and water being brought to near a boil, say 175 to 180 degrees Fah.

Take seven test tubes 5/8 inch by 6 inches, placed in a rack for convenience in filling and for observation. Then with a 25 c. cm. measuring tube, put into the right-hand tube seven c. cm. of the glue solution; into the second, eight c. cm., and so on until they are all served. Then take the tannin solution in the same way and like quantities, except that the left-hand tube is to receive the c. cm. of the tannin, and so on, increasing toward the right. Thus it will be seen that the fourth tube will have the same quantity of each, the glue and the tannin, and those on each hand having varying proportions. The solution should be freshly made and used while quite warm and each tube well shaken when adding the tannin to the glue in the tubes. Ordinarily it is desirable that the glue be such as will combine with an equal quantity of the tannin. Let the set of tubes stand in any safe place for an hour or two and the result in the tubes will be manifest to the observer, and the lesson easily understood.

GELATINE.

(Extract from letter of G. M. Hyams, chemist, to Chas. Dyer, July 7, 1889. relative to the use of glue in timber treating.)

In regard to the preserving process, from my own experiments and analyses, I have become convinced that the quantity of organic acids in the pine wood of our western (Southwestern) country has been much overestimated. Now it is to be neutralized; these acids that some albumenoid substance, such as glue, has to be added to the timber before injecting chloride of zinc. But as this glue, if left in the pores of the timber, would itself decay, it in turn has to be neutralized, and for this purpose tannin is added. If now we can lessen the quantity of glue to be added, we also decrease the amount of tannin to be used, and this makes a double saving.

In order to find out the minimum quantity of glue necessary, I have saturated timber in small pieces with glue and then determined by appropriate methods the excess from my results. I find that the quantity is only about one-fourth that ordinarily recommended. The most important fact, however, of this branch of the subject is the quality of the glue used, as we are seeking here the soluble albuminoid principle for a chemical reaction, namely, the coagulation of the vegetable acids of the wood. We must seek for a different test in our glue than merely adhesion (adhesiveness). To illustrate my meaning—in pieces from the same stick of timber I have used the following quantities for the same size:

Glue costing	5c.	8c.	12c	17c	blood alb.	pure alb.
Took........	15 grs.	11 grs.	4 grs.	1.6 grs.	1.1 grs.	0.3 gr.

You will then readily see that, provided an easily soluble glue costing 17 cents is used, it is really much cheaper than a 5-cent article, which would not be the case if we looked to its adhesive qualities only.

So-called liquid glue is a good illustration also. I believe you have tried this and found it not to be economical. The reason is simply that to render it soluble and liquid, it has to be treated chemically in a way which destroys the neutralizing qualities of the albumen and practically unfits it for our pur-

pose. I am quite sure (confident) that with the right kind of glue a saving of 20 per cent can be accomplished.

PENETRATION OF GLUE.

The tannin and glue chiefly goes into the ends. At the Chicago works the absorption of each varies from 0.017 to 0.034 cubic feet per tie, or 1 to 2 lts. per tie (lit. eq. .035 cu. ft.), so that the solution injected would be 100 times enough to cover the whole surface 1-32 inch thick. But when the water evaporates we have left only the percentage of leatheroid, say 1 to 2 per cent, which would cover surface 1-32 to 2-32 inch.

Chicago, Dec. 3, 1900. O. CHANUTE.

TANNIN EXTRACT.

Sec. 18. The tannin extract of hemlock bark is mostly used in this process, containing from 15 to 30 per cent of tannic acid, presumably about a safe mean of 22 per cent.

(a) As the amount of active properties in the combination, both as to the glue and the tannin, long practice has taught that they should be used in about equal quantities. As the glue is first absorbed, and the tannin following neutralizes so much of the glue as it may reach, the overplus of the tannin being carried back with the returned solution, there is no waste by having the tannin solution markedly stronger than the prescribed one-half of one per cent. The strength of the tub solution of tannin should be tested from time to time by comparison of its action on a reagent, as will be explained later on.

(b) As regards the penetration of the tannin into the timber, although the tannin solution is complete, that is, the acid is held in complete suspension and will go wherever the water will go, yet its action is and must be largely superficial from the fact that it has no such aid or favorable conditions

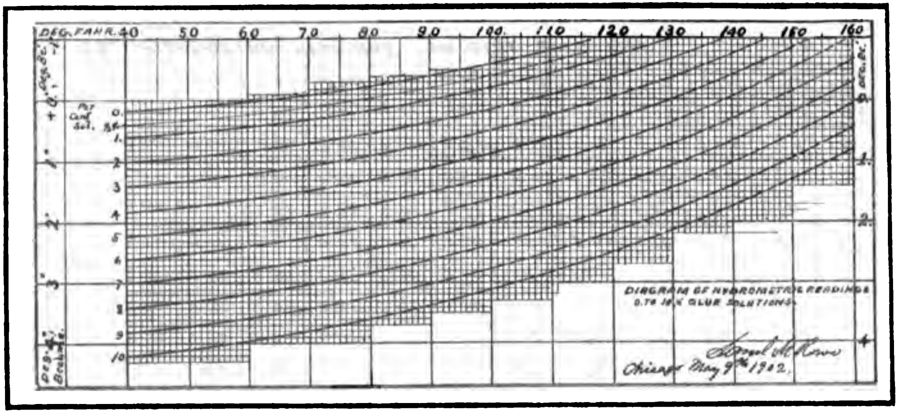


FIG. 35—GLUE DIAGRAM.

This table and diagram is useful where vat contains glue of unknown strength and is only approximately correct.

STR. SOL.	TEMP. F.	40°	50°	60°	70°	80°	90°	100°	110°	120°	130	140°	150°	160°
½ %	. .	1.40	1.32	1.21	110	.98	.79	60	36	.18				
1 .	. .	1.50	1.52	1.42	1.32	1.28	1.00	.78	46	.28				
2 .	. .	2.00	1.92	1.82	1.70	1.55	1.35	1.15	.90	.64	.32			
3 .	. .	2.40	2.30	2.20	2.05	1.90	1.70	1.50	1.25	.96	.65	.24		
4 .	. .	2.80	2.70	2.60	2.48	2.30	2.10	1.88	1.60	1.32	1.00	.60	.15	
5 .	. .	3.20	3.10	3.00	2 88	2 70	2.50	2.25	2.00	1.70	1.34	.95	.48	
6 .	. .	3.60	3.50	3.40	3.25	3.05	2.85	2.62	2.35	2.05	1.70	1.30	.85	.35
7 .	. .	4.00	3.90	3.80	3.62	3.45	3.22	3.00	2.72	2.40	2 05	165	120	.70
8 .	. .	4.40	4.30	420	4.02	3.85	3.62	3.40	3.10	2.78	2.42	102	1.55	1.05
9 .	. .	4.80	470	4.58	4.42	4.25	4.02	3.78	3.50	3.26	2.80	2.40	1.95	1.45
10 .	. .	5.20	5.10	4.98	4.80	4.60	4.36	4.12	3.82	3.50	3.15	2.74	2.28	1.80

TABLE A2. HYDROMETRIC READINGS FOR GLUE SOLUTION

Chicago. Aug 10th 1903.

FIG. 36—HYDROMETRIC READING FOR GLUE.

as does the chloride solution. That there is a portion of the glue not reached by it is a matter of speculation, and it is probable that owing to the viscosity of the glue its action is also largely superficial as well. Be this true, it is what it should be.

(c) The hemlock bark extract carrying the tannic acid is of a reddish brown color, hard when cold, but when under temperature of 100 degrees Fah. or over is the consistency of thin molasses and flows freely.

Its specific gravity is about 1.22, but when a half of one per cent solution, there is no appreciable excess over pure water.

(d) The commercial extract is put into barrels holding about five hundred pounds and over, four or five barrels usually making a batch.

To thoroughly dissolve, a quantity of water is added and a moderate amount of steam is turned in by means of a small steam pipe in the tub, by which the extract is thoroughly agitated and moderately heated, after which additional water can be added, so that some fixed depth from the mixing tub will equal the quantity of tannin needed for each tub foot in the tannin solution tub.

(e) When tannin and glue are combined the mixture, after time is given for the combination of the two, and all unassimilated portions are washed out, and the residuum dried, gives a dark-brown, semi-transparent substance that is quite hard and brittle. It is insolvent in water and incombustible, simply charring to a cinder much as would be with charred leather. Under the microscope it has the appearance of an opaque resin, and a similar substance by appearance is found in the sap cells of the treated timber, not in untreated timber.

Sec. 19. Alkaline waters usually found in the western plains and mountains is, while undesirable, yet not unusable, as while the effect is to some extent deleterious, yet not to the extent that would forbid its use. One of the effects is its liability to combine with the zinc chloride, by which a fraction

of the zinc is thrown down, reducing its effectiveness to the extent of such combination.

Another effect of the alkaline water is to affect the specific gravity for which allowance must be made, the amount to be determined by a comparison with distilled water at 60 degrees Fah. and subtracting the difference from the hydrometric reading in testing tub solution.

CHARACTER OF THE WORK AND APPLIANCES.

Sec. 20. The business of timber treating is not new, neither has it been successfully employed in all cases. It has had to pass through the various stages of development like the manufacture of steel, Portland cement and other lines of manufacture, with its modicum of failures and successes. Now, when success is to some extent attained, it is believed that the exercise of knowledge and intelligence is the only means by which recurrent failure will be avoided. This fact cannot be too deeply impressed; also that a thorough knowledge of the practical part of the business, the movements of the process and the nature of the agent used, and a thorough training in the practical handling of the works are absolutely necessary to good results. In the operator, to all this must be added a determined purpose to enforce all rules and requirements, otherwise *failure will be almost sure and very expensive.*

Sec. 21. To give the operator a fair show to carry the work properly, his convenience and the efficiency of his force, as well as the economical operation of the work, must be considered and carefully provided for.

Every part of the works should be easy of access and compactly arranged so as to be under the eye and hand of the operator.

Every part should be substantially built so that repairs will be infrequent.

Ample store houses and storage for all material

and stock to be used, as well as a good stock on hand, should be provided.

Each machine, pump, engine, boiler, should be selected to perform the kind and quantity of work that is expected from it, as the failure of any one to perform its functions promptly and properly entails a loss of time for the plant and its whole force. Where so much capital is involved, it is worth while to attend to these considerations at the start.

INSTALLATION.

Sec. 22. When the retort and all the machinery are in place and the works generally in condition to commence operation, the following preparatory steps are necessary to prevent confusion and to secure the data that is necessary for future computations and operation.

All tanks, reservoirs, tubs and vats should be filled with water so as to cause the wood to swell to tightness; the steam pipes, with steam and all other pipes, including the retort, with water, so that all leakage can be discovered and cured and that everything be permanently and reliably tight, 150 lbs. cold water pressure to be put on as final test.

The pumps and machinery should be connected and steam put on and everything tested as to its running promptly and in good order.

The retort door should be carefully adjusted so that the gland will correspond exactly with the packing groove in the retort flange and the door swing freely and truly on its hinges; that the locking levers radiate truly from the center and that the "Y" bolts be well adjusted, so that, in closing the door, all the levers will come to bearing at the same time.

VOLUME OF RETORT.

Sec. 23. In computing the amount of absorption, the amount of timber, etc., in volume, it is necessary to know exactly how much the retort holds.

Close the retort, note the indicator reading on

the solution tub, then open the main valve and entirely fill the retort with the water, again reading the indicator, and the vertical feet used by the area of the tub will be the volume of the retort. It would be well to include such number of tram cars as are used in a charge of ties, as this will be used in case of ties at all times. This, if carefully done, is more exact than any computation that could be made.

PREPARING THE CHEMICALS.

Sec. 24. Before proceeding to start the works, each of the chemicals must be prepared in such quantities as will keep on hand a stock sufficient to prevent delay in the work. Each solution tub should be filled to near its full capacity with a solution of proper strength, ready for instant use. For this part of the work a carefully instructed assistant should be employed and held responsible for the proper handling and mixing, and also that sufficient stock is held ready for use.

CHLORIDE OF ZINC.

Sec. 25. The preparation of the stock solution and its dilution in the solution tub is fully treated in sections 17 and 19, so that it is only necessary here to notice the method by which the stock of solution is kept up, both in quantity and strength, by more or less frequent renewals. If three retorts are supplied from a 30-foot tub there will be required something like ten tub feet daily, hence this many tub feet should be supplied each day. This operation consists of pumping so many feet of water into the tub and immediately adding the required quantity of the chloride as indicated in Figures 30 and 31, multiplying this by the number of tub feet put up.

For example, suppose that 8½ tub feet is wanted and the water has been put up, the strength to be 2½ per cent and the stock solution is 40 per cent strong. We see by table "B" that it requires 30.173 cubic feet of stock solution to bring each tub foot

up to 2½ per cent, then 8½x30.173 equal 256.47 cubic feet of stock solution. Divide this by area of storage vat (96 sq. ft.) will give 2.67 vertical feet of the 40 per cent chloride to be put up.

Sec. 26. If more than three retorts are operated, an additional storage vat or a larger one will be necessary, as the above indicates very nearly the capacity of one of the size indicated, and another solution tub will be necessary.

Sec. 27. As before indicated, the solution should be tested by means of the fine Beaumé hydrometer to check the strength, and should it, after being well agitated, be found too strong or too weak, then addition of water in the former or chloride in the latter case is required, the amount of each to be computed as before. The deficit in either case will be proportional as the per cent. Table "B" contains quantities for an error of one-quarter of one per cent, which saves trouble sometimes, and is near enough for most cases.

Sec. 28. The matter of monthlv stock will be now noticed as the same computation comes in here. At the starting of the works, or at the beginning of each month, there is a certain amount of stock in the ware house and perhaps more arriving. To keep a proper account it is necessary to know how much stock has been used in the month, or perhaps in a separate lot of timber, hence the stock account should show just how much is on hand at any moment. This will consist of stock in warehouse, stock in dissolving vats, in storage vat and also in the solution tub, and, knowing the strength of each, the whole can be summed up as if it was still in the original package.

The simple rule for solution anywhere near two per cent will be to call each cubic foot equal to 63.4 lbs. Multiplying this by the total number of cubic feet in the tub and again by the hydrometric strength, will give the number of pounds pure chloride in the solution tub. For mixing and storage vats use table "B."

GELATINE.

Sec. 29. Resuming the consideration of glue from Sec. 17, we will take up its preparation with reference to its immediate use at the works. Glue comes to the works in barrels of 250 lbs. or thereabout, and is dissolved in a small tank or dissolving tub into which some water has been put. The packages first being weighed, then broken, and after turning the glue into the tub the empty barrel is weighed and the net amount of glue noted.

Four or five barrels can be used at one time, filling the tub with water, so that the glue be well covered and left to soak for as long a time as the exigencies of the work will allow; preferably 24 hours. A little steam is then applied so as to render the glue homogeneous, adding further amount of water to bring up the volume so that some fixed measure will indicate how much to throw up for each tub foot of the solution.

If a tub foot contains 664 cubic feet of chloride solution, the weight of which is 63.4 lbs., then there will be a total weight of 42,098 lbs., of which one-half of one per cent would be 210.5 lbs. of glue required for each tub foot. But remembering that in Sec. 17 ten per cent is to be added, brings the amount per tub foot to 230 lbs.

Dividing the amount of glue put into the dissolving tub by 230 lbs., will give the number of tub feet that it will supply with the required per cent.

The strength of the glue, whether mixed with the chloride or used separately, is supposed to remain constant, only needing new supply in proportion to the water added in keeping up the stock of solution.

TANNIN.

Sec. 30. The tannin being applied separately and being the last application is prepared in its separate mixing tub or vat and used from there by means of the same ejector as the glue, diluting it in the tannin solution tub in like manner to the glue.

The tannin solution is absorbed to a very much less degree than the chloride (usually only about one-tenth in volume), owing to the timber having already been well impregnated and to the less favorable condition for absorption. The tannin solution actually loses much more of its tannic acid than is contained in the amount of absorption of the charge, it being remembered that some twenty times the amount absorbed has been in contact with the charge with its quota of glue, and therefore is depleted to the extent of the tannin needed to neutralize the glue, therefore the following: Rule for keeping up the strength of the tannic solution:

"To the amount in volume absorbed add the amount of chloride solution absorbed; to the sum of these add tannin equal to one-half of one per cent in weight of tannin extract."

COMPUTATIONS.

DURING OPERATIONS.

Sec. 31. During the operations of the works it is necessary to know how much timber there is in the charge, how much of each solution has gone into it, etc., so as to be able to know that the work is being properly done and that accurate accounts may be kept of the amount of chemicals used. To do this, the volume of the retort should be accurately taken as before noticed. (Sec. 23), and the various solution tubs should be provided with accurate gauges, by means of which the operator can note the amount in the tub before starting, at various periods between and at the close of the operation.

These gauges should consist of a graduated board divided into feet and tenths, a good float on the solution in the tub and an indicator weight or pointer working freely by means of a cord up and down the graduated face of the indicator board. This indicator should be placed where it will be in plain sight of the operator and should be lighted at night so as to be easily read.

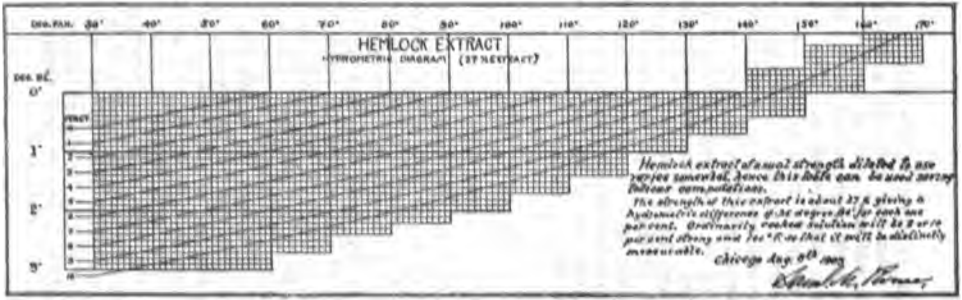


FIG. 37—TANNIN DIAGRAM.

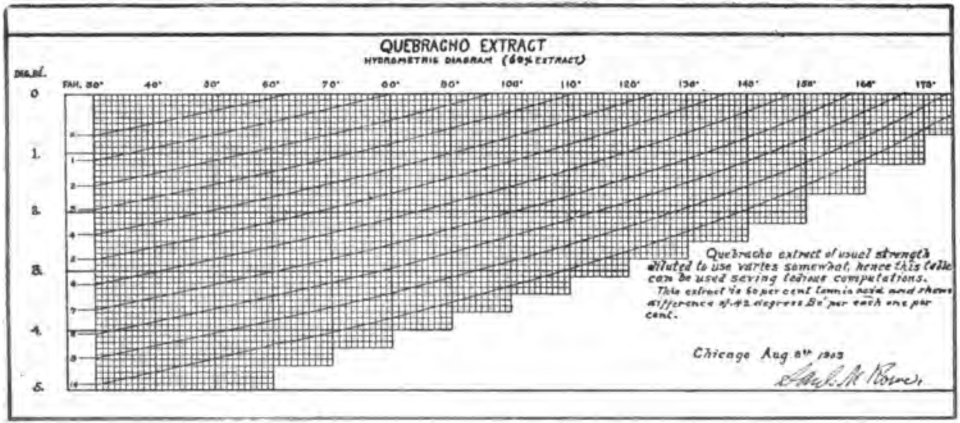


Fig. 46—Quebracho Extract Diagram.

Only useful for stock solution.

This is a gum from a South American tree, high in tannic acid (60% and over), which requires a much higher heat to bring it into action than is necessary with hemlock or oak. With the improved heating coil there seems to be no reason why it should not come into use in timber preserving.

STR. SOL.	TEMP. F. →	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°	170°
1 %	Deg. Bé.	.87	.65	.45	.25	.01										
2 "	" "	1.10	.90	.70	.50	.26	.02									
3 "	" "	1.35	1.15	.95	.75	.51	.27	.03								
4 "	" "	1.60	1.40	1.20	1.00	.76	.52	.28	.00							
5 "	" "	1.85	1.65	1.45	1.25	1.01	.77	.53	.25	.00						
6 "	" "	2.10	1.90	1.70	1.50	1.26	1.02	.78	.50	.22	.00					
7 "	" "	2.35	2.15	1.96	1.75	1.51	1.27	1.03	.75	.47	.16	.00				
8 "	" "	2.60	2.40	2.20	2.00	1.76	1.52	1.28	1.00	.72	.41	.08				
9 "	" "	2.85	2.65	2.45	2.25	2.01	1.77	1.53	1.25	.97	.66	.33	.03			
10 "	" "	3.10	2.90	2.70	2.50	2.26	2.02	1.78	1.50	1.22	.91	.58	.22	.00		

TABLE 12. HYDROMETRIC READINGS FOR TANNIN EXTRACT. (HEMLOCK.)

Chicago. Aug. 10th. 1903.
Saml. M. Rowe.

FIG. 47—HYDROMETRIC READING FOR TANNIN.

STR. SOL.	TEMP. F.	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°	170°
1%	. .	1.12	.92	.72	.49	.25	.02									
2.	. .	1.54	1.34	1.14	.91	.67	.44	.18								
3.	. .	1.96	1.76	1.56	1.33	1.09	.86	.60	.33	.02						
4.	. .	2.38	2.18	1.98	1.75	1.51	1.28	1.02	.75	.46	.15					
5.	. .	2.80	2.60	2.40	2.17	1.93	1.70	1.44	1.17	.88	.57	.23				
6.	. .	3.22	3.02	2.82	2.59	2.35	2.12	1.86	1.59	1.30	.99	.65	.30			
7.	. .	3.64	3.44	3.24	3.01	2.77	2.54	2.28	2.01	1.72	1.41	1.07	.72	.33		
8.	. .	4.06	3.86	3.66	3.43	3.19	2.96	2.70	2.43	2.14	1.83	1.49	1.14	.75	.32	
9.	. .	4.48	4.28	4.08	3.85	3.61	3.38	3.12	2.85	2.56	2.25	1.91	1.56	1.17	.74	.24
10.	. .	4.90	4.70	4.50	4.27	4.03	3.80	3.54	3.27	2.98	2.67	2.33	1.98	1.59	1.16	.66

TABLE A[1] HYDROMETRIC READINGS FOR QUEBRACHO EXTRACT

Chicago. Aug. 10th 1903.

FIG. 48—HYDROMETRIC READING FOR QUEBRACHO EXTRACT.

VOLUME OF TIMBER.

Sec. 32. To compute the volume of the timber in the charge: Take the lowest reading of the chloride indicator from the reading after the solution is fully forced back. This difference is the number of tub feet that was in the retort after absorption is completed, hence, when reduced to cubic feet, will be the number of cubic feet outside the charge, and taking this from the known volume of the retort, the remainder will be the volume of the charge in cubic feet of timber

ABSORPTION OF CHLORIDE, TANNIN OR GLUE.

Sec. 33. Take the indicator reading after completing forcing back from the reading at commencing, the remainder will be the tub feet of solution absorbed. Reduce this to cubic feet, multiply it by 63.4 lbs. (close approximate weight per cubic foot), which gives the number of pounds solution absorbed by the charge. Then again to determine the number of pounds pure chloride, multiply this by the per cent of strength of the solution (hydrometric, say .02 or .025, as the case may be), the product is the number of pounds pure chloride absorbed by the charge.

Then, again, divide this by the total number of cubic feet in the charge as before found, and the result will be the pounds or fraction of a pound of pure chloride per cubic foot of timber.

The same rule applies to absorption of tannin and also glue where it is applied separately from the chloride, only different in the last multiplier, which is .005 or one-half of one per cent.

ABSORPTION BY VOLUME.

Sec. 34. A very useful and instructive test of timber as to its adaptability to receive treatment is determined by its ability to absorb the solution. This

PLATE 18. TABLE I. CONDENSED STATEMENT OF OPERATION OF WOOD PRESERVING WORKS. LAS VEGAS, N. M.

NINE MONTHS ENDING MARCH 27th 1886. S M Rowe Res't Eng'r

MONTH	MURIATIC ACID USED					ZINC USED					GLUE USED					TANNIN USED					COST OF LABOR			COST OF FUEL			TOTAL COST.			AMT. TREATED.	
	Carboys	lbs	Value	Cu ft	Pr tie	Blocks	lbs.	Value	Cu ft	Pr tie	Bbls	lbs	Value	Cu ft	Pr tie	Bbls	lbs	Value	Cu ft	Pr tie	Amount	Cu ft	Pr tie	Amt	Cu ft	Pr tie	Total.	Cu ft	Pr tie	Ave ties	Cubic feet
July 85	18	2272	$ 68.00	1.19	5.28	19	860	$ 34.00	0.60	2.64	2.5	593	22 60	0.40	1.75	1.	320	$ 17.10	0.30	1.33	$ 86.85	1.52	6.75	28.00	0.15	0.65	248.55	4.36	19.30	1288.	5706
Aug -	180	23735	564.10	1.28	5.69	154	7050	282.00	0.64	2.87	26	4760	186 60	0.43	1.88	8.25	4298	141.07	0.32	1.33	656.90	1.50	6.63	97.85			1928.43	4.39	19.46	9909	43892
Sept -	536	67678	1284.11	0.91	4.21	396	18280	718.90	0.56	2.47	54	12852	503 82	0.33	1.73	28.	14588	478.81	0.37	1.65	1836.99	1.44	6.37	138.00			4920.61	3.82	16.78	29062	128745
Octr -	512	64641	1439.63	1.19	5.28	378	17402	713.68	0.59	2.25	33.5	12733	493 14	0.41	1.83	23.75	11875	414.86	0.34	1.52	1630.95	1.35	5.99	228.36			4918.84	4.08	18.05	27245	120696.
Novr -	351	44312	982.34	0.98	4.38	229	10281	421.52	0.46	1.91	43.	9675	441 18	0.45	1.99	18.5	9250	316.35	0.33	1.43	1326.80	1.35	6.00	159.46			3567.68	3.64	16.15	22097	97890.
Decr -	311	39264	892.30	0.94	4.14	249	11434	468.79	0.49	2.18	46.	9488	432 28	0.45	2.19	16.	8336	281.34	0.30	1.36	1209.91	1.27	5.61	117.28			3401.84	3.58	15.78	21569	95327.
Jany 86	311	39254	876.09	0.97	4.29	252	11630	476.83	0.53	2.34	24.5	5841	233 64	0.26	1.15	11.5	7697	259.71	0.29	1.27	1407.20	1.56	6.89	162.00			3415.62	3.78	16.72	20423	90474.
Feby -	342	43177	966.10	1.12	4.95	251	11671	460.86	0.54	2.39	27.	6486	281 74	0.33	1.44	13	6825	230.17	0.27	1.23	1268.87	1.47	6.50	116.16			3323.90	3.85	17.00	19532	86525.
Mar -	416	52520	1187.48	1.02	4.50	310	14536	587.25	0.50	2.23	37.5	8925	367 00	0.30	1.35	23.	12144	409.74	0.35	1.56	1311.32	1.10	4.97	112.69			3965.48	3.39	15.02	26404	116972.
TOTALS	2983	376856	7521.98	0.96	4.24	2244	103064	4169.75	0.53	2.35	302.	71287	2938 03	0.38	1.67	143	75333	2549.14	0.33	1.44	10795.86	1.37	6.00	1142.70	0.15	0.65	29629.61	3.70	16.40	177523	786427
Per Cent			25.85	[illegible]	[illegible]			14.30	[illegible]	[illegible]			10 16	[illegible]	[illegible]			8 76	[illegible]	[illegible]	36 97	[illegible]	[illegible]	3.93	[illegible]	[illegible]	29098.41	[illegible]	[illegible]		
Reference	A	B.	C	D.	E.	F	G.	H.	I.	J	K	L	M.	N.	O	P	Q.	R	S	T.	U.	V	W.	X.			Y.	Z	K.	AA.	BB.

ERRATA

Column BB "Total cub ft for Nov 102790 instead of 97890 and total of Ties 23200 instead of 22097 AA

Also totals of cubic ft for 9 mos = 791327 and total number of ties 178620.

Total of Col B 350193 and Column G = 101937.*

Amount of pure Chloride absorbed (average of 9 mos.)

1st Calculated from Engineers reports = 84/100 of 1. per ct

2nd From chemical combination, that should result from total of Acid and Zinc = 85/100 of 1. per cent.

This is equal to about four times the minimum amount required i.e. 24/100 of 1 per cent

Per cent of Glue absorbed = about 3/100 per cent and of Tannin = 32/1000 of 1 per cent.

*Deducting amount in solution not yet used.

Average cost per cubic ft for 9 months is 3.79/100 cents and 16.44/100 cents per tie.

If no farther breakage is encountered the average March to wit 3 4/10 per cub ft and 15 cents per average tie can be maintained

To cover interest on investment maintenance insurance and supervision there should be added about 7/10 cent per cub foot or three cents per tie making total per tie 18 cents

CALCULATION OF AMOUNT OF PURE CHLORIDE ABSORBED.

Let "a" = Wt of Chl. Sol 1½ % strong = 63.37 lbs cub ft

"b" = average absorption of Chl. Sol = 27.5 percent

"c" = Strength of Solution = 1½ % = .015

"d" = Wt cub ft of wood = 31.2 lbs

"y" = percent of pure Chloride absorbed

Then abc. = lbs per pure Chl per cubic foot = 0.2614 lbs

and $\frac{abc}{d}$ = "y" = 84/100 of 1. per cent

Then by Chemical Formula

Total lbs Zinc used 101937.

Less 2 % loss in impurities = 99897.26"

Combines with (99897.26).73/65 = 112192.24 lbs of Hcl gas

Lbs of commercial acid used 350193. Percent by weight of Hcl. gas = .32 per cent.

Resulting formula. $\frac{(73)}{2\,HCl} + \frac{(152.24)}{6\,H_2O} + \frac{(65)}{Zn} = \frac{(136)}{ZnCl_2} + \frac{(154.04)}{8.6\,H_2O} + H_2$ which makes 209016.60 lbs pure $ZnCl_2$ and 46.70 percent solution.

Timber treated 791327 cubic feet at 31.2 lbs per cub ft = 24689402.4 lbs. then $\frac{209016}{24689402.4}$ = .008466 or about 84/100 of one per cent of wt of timber in pure Chloride

Las Vegas Apr 19th 1886

Saml. M Rowe
Res't Engr.

FIG. 38—CONDENSED STATEMENT OF OPERATION. LAS VEGAS, 1885-6.

FIG. [illegible]—OPERATOR'S REPORT.

is found by dividing the number of cubic feet of solution absorbed by the number of cubic feet of timber in the charge.

RECORD OF ROUTINE WORK.

Sec. 35. To have a complete record of the operation a blank form should be provided for the operator to record every move, the directing column being printed on the right hand with any convenient number of columns in blank arranged to the left, say six for the proper entries in ink, each blank column to receive the record of one run.

The items to be entered are as follows: Run Number; Retort Number; Commenced steaming; Twenty pounds indicated (time); Blow off (time); Commence vacuum (time); Twenty-five inches indicated (time); Indicator chloride tank (feet and tenths); Chloride introduced (time); 100 lbs. pressure indicated (time); Lowest point indicator (feet and tenths); Started forcing back (time); Completed forcing back (time); Indicator chloride tank (feet and tenths); Indicator glue tank (feet and tenths); Introduce glue (time); Force back glue (time); Indicator glue tank (feet and tenths); Indicator tannin tank (feet and tenths); Introduce tannin (time); Force back tannin (time); Indicator tannin (feet and tenths).

Number of ties; Cubic feet of timber in run (computed); Absorption of chloride in vol. per cent (computed); Strength of chloride solution (per cent hydrometric); Absorption pure chloride to cubic foot of timber in lbs. Time consumed in run (hours); time consumed in shift; kind of timber treated.

On left of last column should be date, temperature of solution when tested, hydrometric reading and signature of operator.

With such a report filled out for each and every run, departure from the prescribed routine cannot be concealed, but will be apparent.

While the requirements above say feet and tenths,

it is possible with care to read the indicator to hundredths of a foot, and this should be done.

MEASURING SAPS EXTRACTED.

Sec. 36. Recurring to the practicability of measuring or determining the actual amount of saps extracted from the timber with any degree of accuracy is doubted. It is found that very dry timber, after being steamed, is invariably heavier if withdrawn at end of the vacuum than when introduced, showing that the timber has absorbed a greater amount of moisture than replaces the saps extracted. On the other hand, very green or water-logged timber will be markedly lighter, the only conclusion we can draw is that more moisture has been withdrawn than went in in the form of condensed steam, but how much sap came out or how much condensed steam passed in and remains in the timber is impossible to tell. The fact of the matter is that during the process of steaming large amounts of the saps are blown out with the condensed steam in keeping the retort clear of condensations, the quantity being of such amount as to load the outflowing water highly with the juices of the timber. This is entirely outside of that collected by the hot well, and of much greater volume.

KIND OF TIMBER AND CONDITION.

Sec. 37. The soft and open grained timbers, such as the southern lowland pine and the mountain pines of the west, have been submitted to treatment with a high degree of success. The life of these pines are, when laid without treatment, from three to four and one-half years when cut from young growing timber in the form of pole ties. Later, hemlock, tamarack and even cottonwood have been used with good result, the life when treated by the Wellhouse process being prolonged very much. While sufficient record as to the relative life

TIMBER TREATING PLANT.

MONTHLY REPORT OF TIE AND TIMBER TREATING.

Month Ending............................19....

Total number of ties treated

Number of runs made ____________

" " ties treated, sawed ___ x ___ inches x ___ feet ____________

" " " " hewn ___ x ___ inches x ___ feet ____________

" " " " hewn ____________

Feet B. M. timber treated including switch ties ____________

Lineal feet piling treated ____________

Total number cubic feet timber and piling treated ____________

Total output reduced to hewn ties @ 4 cubic feet each ____________

—COST OF TREATMENT.— Dols. Cts. Dols. Cts.

Chemicals

Zinc ____________ lbs @ ___ cts - $ ____

Gelatine ____________ lbs @ ___ cts - $ ____

Tannin ____________ lbs @ ___ cts - $ ____

Labor ____________

Fuel and supplies

Coal ________ tons @ $ ________ $ ____

Freight ________ cords @ $ ________ $ ____

Oil and supplies ____________ $ ____

Switching and other miscellaneous expenses ____________

Total cost of treatment ________ $

—COST PER TIE.—

Chemicals ____________

Labor ____________

Fuel ____________

Switching, supplies & miscellaneous ____________

Average cost per tie ____________

Average absorption of zinc chloride in lbs. per cubic foot ____________

" " " gelatine per tie lbs. ____________

" " " Tannin per tie lbs. ____________

Product per month stamped ____________

Average time charges were steamed ____________

" " " " in zinc solution ____________

" " " " " gelatine " ____________

" " " " " tannin " ____________

Estimated time timber was cut before treating ____________

Was proportion of heart wood or resin over or under average ____________

Note below anything special in regard to character of treatment or in ties handled during month. Was lumber and ties green or generally well sun dried. Also any variation from usual methods as to pressure vacuum or number of solutions: ____________

Signed: ____________

Superintendent

FIG. 40—MONTHLY REPORT.

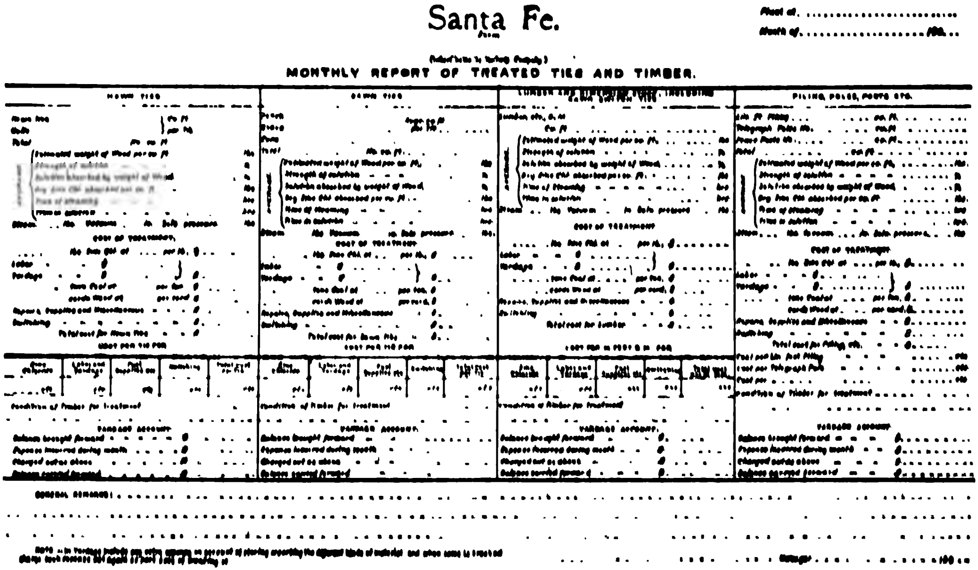


FIG. 11. MONTHLY REPORT, SANTA FE

in each case has not been kept, yet it is presumed that it would be found to be at least double, some estimating it at three times.

In the case of heart timber that is sound and well matured the life can be safely placed at 50 per cent higher, as heart timber is more lasting on account of its maturity and firmness of fiber and greater freedom from fermenting juices.

While it is true that sap and open grained timber will absorb more of the antiseptic solution than well-matured heart timber, and is, by some, considered most suitable for treatment, yet it is not clear that the very best timber cannot be treated with equal profit.

The fact probably is, that any timber, not excluding the best white or buroak, will be benefited to such extent as to be profitable and advantageous by the prolongation of its usefulness.

That a compact timber will not absorb as large amount of the preservative is owing to the large amount of solid wood fiber and the smaller per cent of voids in the timber, which only serve for the lodgment of the preservative, hence this should be no reason for barring it out, but, on the contrary, should be in its favor.

The available voids in timber varies from 20 per cent in volume for compact heart timber to over 60 per cent for Texas short leaf pine. The compact timber is not confined to the oak, hickory, etc., but will be found among the pines. In almost all cases the best timber is found in the lower part or butt cut of the tree.

All in all, it is true that the better the timber the better the tie, whether treated or otherwise, in spite of its inability to absorb so much of the antiseptic.

SEASONING.

Sec. 38. To secure the best possible results, any timber should have such an amount of seasoning as will free it largely of the green saps existing in the

live tree when cut, or to such extent as may be practicable by exposure to a dry atmosphere for perhaps from 60 to 90 days; more time in a damp, rainy climate than in a dry, sunshiny exposure.

Practically speaking, the determination of condition of timber suitable must be largely a matter of judgment with the further aid of actual results when put through the process.

If perforce timber is treated while in a waterlogged or green, freshly cut condition, then special means must be resorted to, prolongation of steaming, interposition of extra vacuum, prolongation of pressure on solution, or all of these, but as a rule this should not be done if possible to avoid it, as the results will be uncertain.

Kiln drying is recommended by some, but this adds too much to the expense and cannot be as good in any case as Nature's action with time.

STORAGE OF TIES IN STORAGE YARD.

Where it is desired to give a season of drying to incoming ties, a method of piling is advised where the air has fair access to most of the surface of the ties. In practice a course of four alternating with a cross course of seven in the case of average hewn ties will do this fairly well. Ties so cribbed in a dry climate have been known to lose the greater part of their water in one month.

STORAGE ROOM.

It is found that if storage tracks are spaced 64 feet center to center six cribs can be piled, still leaving ample clearance for use of tracks by passing cars.

UNLOADING AND PILING.

Where taken from cars the piles can be made as high as the top of the cars, say 12 feet, and if piled as before stated there will be six piles of 110 ties

each every 10 feet of the space between tracks. At this rate the space required per tie would be one square foot of ground in the storage part of the yard. Hence, a yard 1,500 feet long and 350 feet wide would store 525,000 ties. If the ties to be stored are sawed ties, the amount that could be stored would be 25 to 33 per cent greater.

Sec. 39. Live and growing timber with its natural saps and its sap cells in their normal condition will resist the introduction of any fluid, much on the principle that two bodies cannot occupy the same space at the same time. To be able to introduce any solution, the natural saps of the timber must be in some way freed and expelled from the timber either by being evaporated by drying or must be forced out by heating, loosening and expanding into vapor, as is done under the steaming process. The saps in freshly cut timber will immediately begin to evaporate when, under favorable conditions, the timber is exposed to the air, the action commencing on the exposed surface and gradually advancing toward the center of the piece, but if, on the contrary, it is exposed to much dampness and high climatic temperature, the evaporation progresses very slowly and the fermentation of the juices of the timber will act quickly, forming at once the basis of active decay. The time required to dry the timber by exposure to the atmosphere alone will go far toward its destruction, the fermentation of the saps forming the fungi of decay, attacking the delicate cells and more delicate and less compact portions of the timber and then the firmer portions, until, in a few months, the timber becomes spongy throughout. Timber that has reached this stage will take the solution freely, but if decay has gone so far as to allow excessive absorption, it will be of little value even if treated.

Sec. 40. Under the action of steam in the retort, the juices are heated to such temperature as will expel them rapidly, arresting any incipient decay and destroying the delicate mechanism of the sap

cells, clearing the way for the ingress of the solution. Microscopic examination proves this to be true.

It is, therefore, important that the time the steam is held must be adjusted to the condition of the timber, the most important consideration being that its action shall reach the center of the piece.

The rule here adopted is for 20 lbs. pressure, which is equal to 250 degrees Fah., which is the highest degree of heat allowable to which the timber can be subjected without injury. The steam used should be saturated steam, as with superheated steam the temperature is uncertain, while no special advantage is gained.

PENETRATION OF STEAM.

To determine when the penetration of steam during the steaming process has reached the center of the piece, the following is proposed: Fix a connecting pipe to the lower dome, so that the condensation during the steaming can be frequently drawn, the pipe running to a sink in the machinery room, and provided with a small cock. Then at intervals of a half hour, draw from this saving a small quantity to fill a test tube. A rack holding 10 or 12 tubes will suffice for six hours' steaming. The operator will then have before him a means of judging when the off-fall of the timber juices is complete. It is not expected to thus form a definite rule, but to give a hint that may aid very much in determining when the penetration is complete.

The different timbers, of course, give different appearances in the off-fall, hence the operator has to read the signs and draw conclusions. The main point is to know when the timber is *cooked through,* as on this will depend largely the thoroughness of the penetration of the antiseptic, whether it be oil or solution.

THE ECONOMIES.

Sec. 41. The following estimate is based upon the conditions existing on the A., T. & S. F. Railroad line in New Mexico in 1885.

The prolongation of life of the Mountain Pine there used, from a mean of four and one-half years to about twelve years, is quite well authenticated. On this is based the following estimate:

For a period of twelve years.

Untreated tie placed 2 2-3d times

Cost of tie, 35c.x 2 2-3 times......$0.93

Cost of placing in track, 2 2-3d ts. .40—$1.33

Treated tie, one, 35c...............$0.35

Cost of treating, 15c............. .15

Cost of placing, 15c.............. .15—$0.65

Making a saving in twelve years of 68 cents per tie or five and two-thirds cents per tie per annum.

To more fully appreciate what this means, multiply this by 2640 ties in each mile you have $149.50, or approximately $150 per mile per annum. As the works built in 1885 consisted of two retorts, with annual capacity of 400,000 ties, sufficient to renew 300 ties per mile on 1,333 miles, the annual saving on this basis would be something like $200,000.

The Las Vegas Works cost about $30,000, a small part of the annual saving (about 15 per cent).

GENERAL OBSERVATIONS.

Sec. 42. In a general way, the true value of the results must be deducted from the mass of and not from individual cases or of a few specimen pieces.

The variations in density and other conditions are as various as there are varieties of timber or parts in the tree. Then again, even with the most careful inspection timber more or less unsound will come with the rest, to disturb the investigator should he resort entirely to chemical analysis on which to found an opinion as to the thoroughness of the treatment or the value of the results.

Speaking from a practical point of view, the following line of reasoning will apply: The agents used are commercial commodities used in gross amounts as salt is used to preserve meat, a small

variation cutting a figure only where large quantities are used, where system will conserve economy, but where no slight variation will affect the efficiency of the treatment. In this the chemist can guard against the purchase of adulterated stock.

Again, the rules and methods for the zinc-tannin and kindred processes are so well defined that the operator, with the exercise of good judgment, can get almost any desired result, and will know just what he is doing as to amount of absorption. He will know that when he puts in a tie weighing 100 lbs. and it comes out weighing 175 lbs. that it has absorbed 75 lbs., no more, no less, and knowing the strength of the solution, he can safely say that it has just so much pure chemical agent, whatever it may be in it. To determine how much has been absorbed by any or every particular piece in the charge is manifestly impracticable, hence only the gross result is manifest at the time.

It must be remembered that each of the different processes have been carried on for years, and their effectiveness and value are no longer in the field of theory, the proofs of effectiveness having been secured after the lapse of sufficient time to amount to a demonstration. The chemist may find a tie that has been in service 15 or more years that has but a trace of the chemical, and he may find one of the same timber that has failed at less than five years, both having been treated in the same charge, yet for reasons before given this proves nothing as to the real value of the process or of its failure.

The operator that is armed with a thorough knowledge of chemistry has something that will be of great aid to him, but he will find it of much more importance to study the mechanical and physical features of his work, for instance, whether his steam reaches the center of a tie, what the best temperature for his solution, how various timbers are best rendered penetrable, and a hundred other matters vital to the success of the process.

CAUTIONARY.

Sec. 43. In conclusion, and at the risk of repetition, the operator is reminded that it is of the utmost importance that every part of the work is carried out according to the rules laid down, that the condition of the timber be carefully studied and the best method be adopted to meet this, that every precaution be taken to detect any failure that may occur and to take the proper means to rectify this even to a repetition of the treatment, and to labor to instruct those under him in the highest possible degree to the same end.

By no other means can good results be surely obtained, and any mistakes escaping his vigilance, while not immediately apparent, will tell seriously some time in the future.

Extraneous influences will often be brought to bear to have received and treated timbers not in proper condition to be treated, but such should be received under protest if received at all, and a record should be made of these facts. In this way only will the process be protected against unfair charges of failure.

The operator probably will have little control as to timber delivered to him for treatment, but it is his duty to see that each different class or kind is treated separately as far as is possible, and to study the method of handling the process best adapted to each, bringing every check in his reach to bear, not forgetting the weighing and other means of developing the best methods.

BURNETTIZING.

For the Burnettizing process the appliances are the same as for the Zinc-Tannin except that the tubs for the glue and for the tannin can be omitted and that part of the pipings by which they connect to the retort are also omitted. The precaution is usually taken to put in connections for the piping so that in case of change to the other process, that much labor and expense is saved by so doing.

FOR CREOSOTING.

(a) The additions necessary to provide for creosoting are the necessary storage tub, which should be ot metal, as well as a dumping tank in which the oil is dumped from the tank car in which it is usually shipped to the works. The capacity of the storage tub depends upon the desired capacity of the works or the portion of the works devoted to creosoting and the amount of timber that is to be treated.

(b) The same pipes are used as with the Burnett except, of course, the main pipe to the header, but these pipes through which the oil is passed must be provided with inside steam pipes by which the oil shall be kept fluid by means of live steam passing through them.

(c) In addition to this the retort must be furnished with a system of heating pipes (steam) of such heating surface as will quickly heat the oil in the retort to the desired temperature. This is done by manifold coils of iron pipes. As the oil must at all times be entirely fluid, the storage and the dumping tubs must also be provided with ample heating coils.

The absorption is secured in the same way as with the Wellhouse or the Burnett process, first bv opening the pores of the wood bv steaming, followed by the oil under pressure aided by a much higher temperature on the oil.

UNITS IN COMPUTATIONS.

Sec. 44. Line measure feet, tenths and hundredths, to three decimals.

Cubic measure, cubic feet and fractions to three decimals.

Tub or vat feet equal area of tub or vat x 1 foot (vert.).

Weights, lbs. Avoirdupois to one to three decimals.

Gallons U. S. equal 231 cubic ins., not used as being less convenient than cubic feet.

Weight of water at 60 deg. Fahr. equal 62.4 lbs. per cubic foot, or .5775 per oz. Av. (Sea water said to be 64.1.)

Pressure, steam and cold water is counted as per square inch in lbs. Av.

Temperature, Fahrenheit Thermometer (always).

Weight of concentrated sol. $zncl_2$. See table (B) Empiric.

Per cents should be carried to three decimals.

Means by weight except where otherwise specified.

LAGGING THE RETORT.

The practice in regard to providing nonradiating covering for the retort is quite varied. There is no doubt that an economy of fuel results, but, on the other hand, experienced operators claim that there is a loss of time and more difficulty in securing a perfect vacuum, owing to the slow cooling of the retort after the steam is discharged. If the retort room is closed, the temperature gets very high so that the radiation is not very great after the heat in the retort gains the maximum and when steam is drawn, and by the same line of reasoning the retort room should be opened. This is not usually done, however, and the practicability of doing so is doubted, as usually some one of the retorts reach this stage at almost any hour of the day.

In case of the outdoor portable plant, the lagging seems advisable as the radiation is necessarily great. More light will be necessary to decide whether the additional cost of the lagging is justified in the covered works.

TEST OF STRENGTH.

ZINC CHLORIDE SOLUTION.—Powers.

The apparatus necessary consists of a graduated glass burette and an ordinary coffee cup. The sketch shows the method of making the analysis.

A is the glass vessel containing the zinc solution diluted with distilled water containing a little potassium monochromate. B holds the standard silver nitrate which is delivered into the cup (A) by means of the pinch cock. As long as there is any free zinc chloride left in A, the solution will remain yellow from the potassium chromate, but the moment it has all reacted with the silver nitrate, one drop in excess silver nitrate solution reacts with the chromate to form a blood red solution, so if we take a definite volume of zinc chloride solution in A, and have the silver nitrate in B of the right strength all we have to do is to simply read off the number of c. c. of B solution used and we have the strength of the zinc solution direct.

A correction has to be applied in making up the strength of the silver nitrate solution because of the presence of chloride of sodium in the water used   From Geo. W. Noyes.

The use of the metric system will only be noticed so far as is applicable to the graduated measures used in testing laboratory, the larger measures and weights usual in the metric system being less convenient for the ordinary computations of volume of tanks, retorts, volume of timber, etc., than the cubic foot (U. S.) as the unit.

The plant of the Mexican Central Ry. Co. is arranged for the metric system and the following equivalents will be convenient for converting these to cubic feet, pounds, etc.

ONE GRAMME.

1	gramme	=	15.4322 grains.
1	"	=	1 c.cm. of pure water at 39.2 deg Fahr.
1000	"	=	2.2046 lbs. Av. (= 1 kilogramme).
1	"	=	.0022046 lbs. and
1	"	=	.0352736 oz. and
1	"	=	15.4322 grains.

LINE.

1 centimeter	=	.393704	inches, =	.032809	feet.
1 decimeter	=	3.93704	" =	.328087	"
1 meter	=	39.37043	" =	3.280869	"

SQUARE.

1 square meter equals 10.763 square feet.

CUBIC.

1 cubic centimeter	=	.0610254 cubic inches.
1000 "	=	1 litre.
1 cubic meter	=	35.3105 cubic feet.

WEIGHTS.

1 kilogramme	=	2.2047 lbs. avoirdupois.
1 gramme	=	15.433 grains (1-7000 lb. av.)

EXPANSION OF FLUIDS BY HEAT.

Water expands in volume :

Per degree Fahr.,	$\frac{2424}{10000000}$ or .0002424	= 1.
Creosote oil,	$\frac{4727}{10000000}$ or .0004727	= 2.
Stock chloride of zinc, 46%,	$\frac{3171}{10000000}$ or .0003171	= 1.3

IMPLEMENTS FOR TESTING SOLUTION.

Sec. 45. One avoirdupois scale, 4 lbs. down to grains.

One graduated glass test tube, 200 c. cm. will do, 1½ inch. dia. x 12 inch.

One 1000 c. cm. graduated glass to set on scale, with counterbal.

Two plain test tubes, 1½x12 inch.

Two dozen test tubes, ⅝x6 inch, with cork stoppers.

Two glass funnels, 3-inch dia.

One package filters, 6-inch.

Two open glass jars, 4-inch dia. and 6-inch high.

Two Beaumé hydrometers, 0 to 60 deg.

Two Beaumé hydrometers, 0 to 6 degrees, test to exactly 0 in pure water at 60 deg. Fahr. (duplicates to meet accident).

One floating thermometer, Fahr. zero to 250 deg.

One argand lamp with stand.

Six four oz. glass beakers.

Three porcelain saucers, say 4-inch dia.

Two galvanized iron pails, 4-inch dia. and 12 inches deep, with wire bail to handle samples of solution.

A half dozen or more glass bottles holding a pint or more and having ground glass stoppers will be useful to hold various reagents used for testing the solutions, some of which are noticed below.

REAGENTS. Methyl Orange, a 1-1000 solution for testing for free acid in the chloride solution.

Ammonia for testing for iron.

Barium chloride for sulphates.

Alum and glue for tannin solution, etc.

TO TEST STRENGTH OF TUB SOLUTION OF TANNIN.

(1.) Prepare reagent as follows:

Pure water, one liter (1000 grammes).

Best glue, three grammes (50 grains approximately).

Alum (sulphate), one gramme (16 grains).

Heat to 100° Fahr. and let stand 24 hours to dissolve, then bottle.

(2.) Make up a small quantity of one-half of one per cent tannin solution as follows: Presupposing that a sample quantity of known strength in tannic acid is kept on hand, then take 12 ounces pure water, add to this 26¼ grains tannin extract (30 grains is close enough), warm and mix well, then filter well through two sheets of filter paper and bottle for further use.

(3.) Then take a small sample of the tub solution, filter well as with the testing solution, then take from each ten cubic centimeters and put each into a test tube by itself adding the same amount of the reagent (No. 1) to each, shake well and cork.

The glue will combine with the tannin in each, the combination settling to the bottom so that the relative amount will be apparent to the eye in two or three hours. If the tannin is all taken up, the supercumbent water will be nascent and clear of color; if not, and the amount of glue is insufficient, the water will be tinged red, and if on the other hand there is more glue than tannin, the water will be turbid and of a whitish tinge. If, however, the tannin is anything near the standard the above will do.

For the following, we are indebted to Octave Chanute, C. E.:

FOR TESTING PURITY OF ZINC CHLORIDE. ($ZnCl_2$).

For Sulphates. Taking two or three per cent solution, add a little barium chloride. If the result is a milky white precipitate it shows presence of sulphates. The precipitate is barium sulphate.

For Free Acid. To a two or three per cent solution of $ZnCl_2$, add a few drops of methyl orange solution (1-1000 solution), and if the methyl orange changes color it shows presence of free acid.

To remove this, one of the most objectionable features and most easily removed, place sufficient zinc

spelter (metallic zinc) in the neutralizing vat to combine with and take up the free acid.

For the presence of iron, one of the most injurious of impurities, add ammonia, and shake well. If there is a reddish brown flocculent precipitate, it indicates the presence of iron and the precipitate is ferric hydrated iron. The presence of over one-half of one per cent, should condemn the chloride. For timber preserving even less than this sometimes considered sufficient to condemn.

VISUAL TESTS OF THE VARIOUS CHEMICALS.

Ordinarily it is difficult to obtain an operator who is sufficiently proficient in chemistry to test the various chemical agents in use and at the same time having the requisite experience in the practical part of the operation, and it is here questioned whether it is at all necessary.

With the ordinary intelligent business man visual tests easily understood and quickly applied are the most desirable.

Some of these are here given and more will be developed by intelligent operators from time to time.

VISUAL TEST OF DENSITY, STRENGTH AND PURITY OF FUSED CHLORIDE OF ZINC.

FOR DENSITY.

Put 140 cubic centimeters of pure water into a 200 c. cm. tube, equals 8.3456 cubic inches, then add two ounces of the pure chloride fresh from the drum. After the chloride is fully dissolved and the heat generated in dissolving it has been given off and the solution reduced to the original temperature (60 deg. Fahr.), then note the reading in the glass. The increase will be the volume of the fused chloride in cubic centimeters, from which the density can be calculated.

Reading equals 156 c. cm. equals 2.0483 ounces per cubic inch or 350 lbs. per cubic foot.

STRENGTH.

If the chloride is measurably pure, the total weight of the 140 c. cm. water (4.9339 oz.), plus the two ounces of fused chloride divided into the two ounces chloride will give the per cent of strength, the hydrometer reading 29 per cent while the figures will be 28 84-100 per cent.

PURITY.

If the water is pure and the chloride also, the contents of the tube will be clear as crystal, but usually it is difficult to get water entirely free from lime or other slight impurities, which will be shown in a white flocculent deposit at the bottom of the tube.

If the chloride is not pure this will show itself by letting the tube stand for a number of hours, the impurities settling to the bottom, when the proportion of impurities can be read on the graduation tube.

Some of the zinc spelter used in the manufacture of the chloride, especially the Missouri zincs, have a considerable amount of lead which produces a chloride of lead of heavier specific gravity, causing it to settle to the bottom, the line of separation being clear and distinct. Some chlorides have been found to contain near 10 per cent of this with other like impurities. Pure chloride of zinc will always remain clear and pellucid.

Example: Using 200 c. cm. graduated cylinder.

Take pure water 5.2861 ozs. (equal 150 c. cm.), add 4.3250 ozs. pure $Zncl_2$ (fused) for a 45 per cent solution. Let it dissolve and remain in 200 c. cm. tube and observe the settling.

4.3250 ozs. at 8 c. cm. per oz. equal	34.6 c. cm.
5.2861 "	150.0 water.
January 5 all dissolved	184.6 c. cm.
	Hyd. Be. 45 per cent.

Impurities equal 26.5 c. cm. divided by 184.6 c. cm. equal 14 35-100 per cent.

TEST OF TANNIN AND GLUE.

The basis of such tests will be a gallon of the tannin (hemlock extract), the strength in the tannic acid being first carefully determined, say from 23 to 28 per cent usually, then for a "suitable glue."

Take 12½ ounces of the pure water and one-half ounce of the tannin, heat to 180° Fahr. and stir well.

Take the same amount of water with half ounce of the dry glue, boil until glue is thoroughly dissolved, requiring 180° Fahr. Bottle both and use before cooling. Then measure this four per cent solution into test tubes as described below, and set in warm place, say from 80° to 110° Fahr., each tube being well shaken. Set over night and combination will be complete, the condition making it manifest in which proportion it is most complete. If the combination is complete with equal parts, we have the suitable glue; on the other hand, if most complete with a less amount of tannin and a larger amount of glue, it is deemed undesirable. The value of glue for the purpose is in the amount of gelatine it contains. The higher grades lose some of the gelatine in refining.

It is probable that this same method may be found practicable in determining the approximate strength of tub solutions of either glue or tannin, as the affinity between these two chemicals is so strong that they will combine even when mixed with any amount of other impurities.

To make this test, take seven tubes, ⅝ inches diameter and 6 inches long is the most convenient, setting them in a proper rack. With a 25 c. cm. graduated cylinder, measure into No. 1 at the right hand 8 c. cm. of the glue solution, nine in the second, ten in the third and so on to 14 in the seventh. Then take of the tannin solution 14 c. cm. for No. 1, 13 for No. 2 and so on reversing the quantity to that of the glue. The middle tube having equal quantity of each, the tannin will combine and throw down the glue leaving the water quite clear as long as the combination is complete and the amount of leatheroid will settle to the bottom of the tube in a quantity in proportion

to the amount of glue, gradually increasing toward the left until the quantity of glue becomes too great when the glue or the unconsumed portion of it will remain in suspension rendering the water turbid and reducing the deposit of the leatheroid.

TO DETERMINE WHEN THE TIMBER IS COOKED THROUGH.

The plant should be so constructed that the condensation during steaming can be drawn off frequently, say every thirty minutes. A small pipe leading from the blow-off to the sewer can be brought to a sink in the engine room so that a small quantity can be secured and placed in a test tube in a rack placed in the window where it is easily observed.

Usually the operator can judge very closely when the timber juices are exhausted and thus avoid wasteful continuance of the steaming. With most timbers three and a half hours is sufficient.

TO DETERMINE THE EFFECT OF STEAMING AND VACUUM.

It will aid the judgment very much by weighing a car or two in a charge before introduction, again after vacuum, and again after withdrawal at the completion of the treatment. Timber very dry on introduction will be found slightly heavier after the vacuum, but very green fresh cut timber will be found lighter, having given off more of its saps than it has absorbed of the moisture of the steam.

BURNETTIZING, CREOSOTING AND OTHER PROCESSES.

BURNETTIZING.

We think it worth while to insert a paper written by Harry Grimshaw in 1885, in full. His description of the "Burnett" process is too concise and complete; so free from technicalities, and couched in terms easily understood, and his paper is so complete—a compendium of the state of the timber preservation of that time—that it is deemed worthy of reprint here.—ED.

ON THE PRESERVATION OF TIMBER FROM DECAY.

BY HARRY GRIMSHAW, F. C. S.

The perishable nature of wood, especially when placed in situations where there is an excess of moisture in the surroundings, has led to many experiments with a view to discover a process of treating timber with salts or oils that would preserve it from decay.

Dry rot, sometimes called sap rot, the most formidable disease to which timber is subject, is commonly attributed to a combination of the acids found in the sap with the oxygen of the air, which produces fermentation, followed by decomposition. Unseasoned timber, placed in damp situations, with partial ventilation, will soon show signs of dry rot. Beams,

which presented the appearance of being sound on the outside, have been found completely rotten on the inside. The shell remains sound because it becomes seasoned and relieved from the sap.

Wet rot (as distinguished from dry rot) is considered to be occasioned by alternate exposure to moisture and dryness, beginning at the surface of the timber and working inward. Piles and other timber placed in salt or fresh water will show signs of wet rot at the water line before it attacks other parts. Posts, set in the ground, first begin to rot at the ground line.

Among the earlier investigators on the subject of preserving timber may be mentioned Johann Glauber, the famous chemist of Carlstadt, Germany, who in 1657 experimented with vegetable tar and pyroligneous acid, the wood having been first carbonized by the action of fire, then covered with a coating of tar and immersed in pyroligneous acid. Since this period many processes have been tried, but most have not survived. either through cost of material or difficulties in their application. Since then, up to 1846, no less than forty-seven (47) different processes adapted for the preservation of wood are recorded, besides others of more recent date. Of these processes, many of them would, no doubt, prove effective, provided they could be carefully and economically applied. It is a difficult problem to treat timber in large quantities and meet with reasonable success. The condition of the timber that is to be treated should always be considered. It should be sound. The trees should be cut during the season when the least amount of sap is flowing, which in this country is in the winter, say from November to February. It should not be treated in a frozen state, and it is advisable to shape the timber to the form in which it is to remain before the treatment is applied.

Seasoning is a very important factor. A few months of exposure to the air and sun will materially add to the durability of the wood. The process of treatment must be rigidly and faithfully performed. The opportunities of gross frauds which cannot

readily be detected, are many, and the numerous instances on record, where cheating has been systematically carried on at works established for the purpose of treating timber, prove that the safest course for parties using preserved timber is to do the work themselves.

Three of the well-known processes for preserving timber are the following, viz.:

1. Creosoting, Creosote oil (so called) being the antiseptic.

2. Burnettizing, chloride of zinc being the antiseptic.

3. Kyanizing, corrosive sublimate being the antiseptic.

CREOSOTING.

The creosoting process consists of injecting timber with hot creosote oil, in a closed cylinder, under pressure. It was invented in 1838 by John Bethel, who found that by forcing at least seven pounds of creosote oil into each cubic foot of timber, the process was satisfactory for railroad sleepers and other railway work, but that for marine work it was better to have not less than ten pounds per cubic foot. In other countries, experimenters have used from ten to twenty pounds of creosote oil per cubic foot, and the estimated cost is from sixpence to a shilling per cubic foot, or fifty to one hundred shillings per thousand feet, board measure. Creosote oil (such as is most commonly used in this country and abroad for the treatment of wood) is distilled from coal tar. It is a heavy oil which will sink in water, and contains carbolic acid, creosote, and other constituents considered effectual for the preservation of wood. Creosoting is far from being a cheap process, and for this reason perhaps more than any other, it has failed to be extensively adopted in America. Creosoting meets with favor in England, and at the present time it is the only process that is carried on with any degree of magnitude and success.

BURNETTIZING.

Burnettizing was introduced by Sir William Burnett, in 1838. The invention consists of destroying the tendency of certain vegetable and animal substances to decay, by submitting them to the action of chloride of zinc. The degree of dilution recommended by Burnett is one part by volume to fifty parts of water. The method of impregnating the wood under a pressure of seven to eight atmospheres, as is done in the creosoting process, is most commonly used. The cost of burnettizing is less than one-third of the cost of creosoting. There are no burnettizing works of any extent in America at the present time. Some of the railroads in various parts of the country have experienced good results from the burnettizing of ties, especially ties of soft wood, such as pine, tamarack, hemlock and ceder. Among them may be mentioned the Rock Island and Pacific Railroad, the Lehigh and Susquehanna Railroad, and the Vermont Central Railroad. The process was introduced at Lowell, in 1850, and conducted faithfully for about twelve years, during which period a very large amount of timber was burnettized for bridges and other structure purposes in exposed situations.

In Germany, burnettizing meets with more favor. The Stuttgart Technical Convention of 1887 expressed itself as follows:

"As the experience of those railroads that have from twenty-five to twenty-six years impregnated their sleepers with chloride of zinc, under pressure, after steaming and abstracting the sap, has been very satisfactory, and as this system costs only one-third or less compared with impregnation with creosote or corrosive sublimate, many of the railroads have adopted the chloride of zinc process."

Steaming the wood under a pressure of sixty to seventy pounds per square inch, as done in Germany, preparatory to burnettizing, no doubt adds to its durability. Tredgold considers that steamed timber shrinks less and stands better than that which is naturally seasoned. Barlow, another good authority,

is of opinion that the seasoning goes on more rapidly after the piece is steamed.

KYANIZING.

This process was invented and introduced into England in 1832, by John Howard Kyan. It consists of steeping the wood in a solution of corrosive sublimate, and the degree of dilution is usually one pound of the salt to ninety-nine pounds of water.

It is a very slow process compared with those in which the wood is impregnated under pressure, and requires about as many days for treatment as creosoting or burnettizing would require hours.

The usual rule in America is to allow the timber to steep in vats for a length of time, depending upon its least thickness, thus, if the timber is ten by twelve inches thick, it would remain in the vats eleven days; if six by nine inches, it would steep seven days. Bichloride of mercury, which is the antiseptic in this process, contains muriatic acid, which acts upon iron, and it is found impracticable to attempt to impregnate the wood under a pressure in iron cylinders, as can be done when creosote oil or chloride of zinc is used. Kyanizing was introduced in Woolwich by the royal engineers in 1836, but has gone out of use in England. The great cost of the material no doubt has been the chief cause of this, as a material costing 3d 6s per lb. has small chance of adoption where creosote is about 3d. per gallon, and pure chloride of zinc under 2d per pound, although in America, where these two latter named substances are not so readily obtainable, the kyanizing process of impregnation with bichloride of mercury has recently been carried on.

The only rival therefore to creosote as a preservative of timber, is the chloride of zinc, and now that the means of production of the latter have rendered it so cheap, it is becoming largely adopted on the continent, and the English railway companies, mine owners, and other users of timber should, in their own interests, study the application of this substance as

preservative from decay. At the prices ruling at the present time, the chloride of zinc process (originally denominated burnettizing) is less than one-third of that of creosoting, and in view of the fact that creosote and other heavy oils are destined to be more largely used as fuel, the economy effected by the use of the chloride of zinc will become greater.

Railway companies especially would benefit, both by the lower cost of the process and by the fact that large quantities of creosote would be released from use for timber preservation, and so be available for fuel under their locomotive boilers.

As to the cost of the process, it is found that the solution of chloride of zinc, of the right strength for preserving of timber, is of about four per cent Twaddle's hydrometer, or 1.02 specific gravity, and the price of this to-day is about seven shillings per ton. The price of creosote oil in most places will be at least two pence per gallon, which is equal to thirty-seven shillings per ton, or five times that of the chloride of zinc solution.

There can be no question, therefore, of the initial advantage, i. e., that of the actual price of the one material over the other. Should there be any necessity to transport the material to a distance, the advantage becomes more pronounced. The chloride of zinc is now manufactured in a solid form, which is *fifty* times as strong as the solution used for "burnettizing," the freight being thus reduced to *one-fiftieth*. In case of export, this is, of course, an immense advantage, which is further added to by the fact that chloride of zinc is absolutely *noninflammable* and is noncorrosive, and can be packed in either wooden casks or iron drums of an inexpensive description.

As to the mode of application, exactly the same plant as that used for creosoting is adapted to the use of chloride of zinc, and the same "modus operandi" is followed out, namely, that of injection under pressure in closed vessels, preferably after previous exhaustion of the air from the vessels.

In cases where it is not practicable to employ the usual apparatus for creosoting, and the timber has to

be submitted to simple immersion in the fluid for a longer or shorter time, the chloride of zinc has a great advantage over creosote oil on account of its greater fluidity and greater affinity for the soluble matters of the wood, which causes it to penetrate more rapidly and deeply into the pores.

Where simple "soaking" or "pickling" of the timber is adopted, the vessel used may be a tank of wood or iron, or may be of brick or stone sunk in the ground. At one establishment there are used two tanks or vats built in the ground with bricks. They are fifty feet by eight feet six inches and four feet six inches deep. The inside course is best of blue bricks, set in pitch, or ordinary bricks soaked in melted pitch. Such a tank will last for years without repairs, and will hold from twelve to fifteen thousand feet, board measure, of timber.

It is a noticeable fact that in the treatment of timber by absorption in this way, if it is immersed while containing sap, i. e., in a more or less green state, the chloride of zinc penetrates more quickly and farther than when dry, but the amount of material taken up is not so great.

After treatment with the chloride of zinc, it is the practice of some of the continental railway companies to give an outside coat of hot tar oil, in which some pitch has been dissolved.

The great importance of an extremely cheap and efficient mode of preserving timber, is apparent when it is borne in mind that in the form of railway sleepers and similar objects, soundness and durability are prolonged to some two to four times that of timber in its natural state, and seeing that the forests and timber supplies of almost all countries are rapidly decreasing in extent, the question of economically lengthening the period of usefulness of wood used for railway, mining, and other outside work, becomes one of almost national importance.

The object of this paper is chiefly to point out, that in this country it appears to have been quite overlooked that the admirable process discovered by Sir William Burnett, has now, through the develop-

ment of the manufacture of chloride of zinc, become the most economical method extant, for the preservation of timber from decomposition and decay.

For information as to processes carried on in America, the writer is much indebted to Mr. James Francis, of Lowell, in a paper read before the New England Cotton Manufacturers Association.

PATENTED PROCESS OF TREATING TIMBER.

CREOSOTING.

The improved process herein described of impregnating timber with preservative fluids, consisting in placing the timber in the retort with vents left open to the air, then introducing creosote in sufficient quantities to submerge the timber in the same, then heating the timber and the creosote to a temperature above the boiling point of the sap at ordinary atmospheric pressure whereby the sap is expelled from the timber, then closing the vents of the retort and by the application of pressure forcing the creosote into the pores of the timber to take the place of the evaporated sap, substantially as described.

Covered by Letters Patent No. 11,515 Dec. 3, 1895, issued to W. G. Curtis and John Isaacs of San Francisco, Cal., to whom application for right to use should be made.

This notice of this patented process is inserted by permission of the patentees, the author desiring to embrace all possible information of interest relating to timber preservation. The standing of these men—John D. Isaacs, C. E., and W. G. Curtis, C. E. (deceased), pioneers in the business, is such as to vouch for the value of the process. If, as it is claimed, the steaming can be omitted, there is a distinct saving of time and a corresponding saving in cost. It must be held in mind, however, that timber differs so radically in different parts of even the United States that its value can only be determined by actual trial. The statement of operation and of cost of treating, both Burnettizing and creosoting, here inserted, is furnished by John D. Isaacs, C. E., engineer of maintenance

of way of Southern Pacific Railway, and is so complete and well arranged that it is thought proper to give it place here. The cost of treatment varies considerably with locality This is net cost to the railroad company and does not cover investment, interruption of operation or operators' profits, when the business is conducted as a commercial enterprise.

SOUTHERN PACIFIC COMPANY.

(Pacific System.)

STATEMENT OF COST OF BURNETTIZING CROSS TIES FOR THE YEAR ENDING JUNE 30, 1902.

At Dietze, Cal. (Portable Plant.)

Months, 1901.	No. of Ties Treated.		Absorption Zn. Chl.	Cost of Treatment Per Tie—Cents.				
				Zn. Chl.	Fuel.	Labor.	Mainte-nance.	Total.
July.....	(7x8)	49,062	.60	4.58	1.47	2.82	.57	9.44
	(6x8)	9,775						
August..	(7x8)	113,423	.60	3.79	.58	3.09	.10	7.54
	(6x8)	16,300						
Sept.....	(7x8)	96,096	.60	3.72	..05	3.22	.12	8.11
	(6x8)	11,193						
October..	(7x8)	99,302	.60	3.85	.68	3.00	.09	7.72
	(6x8)	19.412						
Nov......	(7x8)	91,184	.60	3.90	1.29	3.12	.09	8.40
	(7x8)	10,049						
Dec......	(7x8)	42,455	.60	4.07	.41	3.13	.67	8.26
		558,319	.60	3.89	.88	3.06	.19	8.05

Cost of moving and setting up.......................... .25

8.30

491,512 7x8 inch ties

66,807 6x8-inch ties—to 548,780 7x8-inch ties: cost per ties 8.20

At Latham, Ore. (Portable Plant)

Months, 1903.	No. of Ties Treated.		Absorption Zn. Chl.	Cost of Treatment Per Tie—Cents. Zn. Chl.	Fuel.	Labor.	Maintenance.	Total.
Jan......	(6x8)	8.903						
	(7x8)	97.777	.60	3.73	.84	2.79	.12	7.39
Feb......	(6x8)	75.397						
	(7x8)	21.297	.60	3.65	.73	2.60	.16	7.74
April....	(6x8)	62.324						
	(7x8)	53.490	.60	3.78	.08	2.43	.37	6.66
May......	(6x8)	49.023						
	(7x8)	69.815	.60	2.69	.60	2.42	.08	5.87
June	(6x8)	20.540						
	(7x8)	38.142	.60	4.51	..	3.42	.70	8.63
		496,776	.60	3.57	.51	2.63	.24	6.95

Cost of moving and setting up.......................... 32

7.27

216.187 6x8-inch ties
280.591 7x8-inch ties—to 465,910 7x8-inch ties. cost per ties 7.81

At Oakland, Cal.

Months, 1901 1902.	No. of Ties Treated.		Absorption Zn. Chl.	Cost of Treatment Per Tie—Cents. Zn. Chl.	Fuel.	Labor.	Maintenance.	Oil waste and Water.	Total.
Sept......	(7x8)	38.454	.60	3.77	1.23	2.30	......	.21	8.51
October..	(7x8)	69.151	.60	3.60	1.01	2.80	.38	.12	7.86
Feb. '02..	(7x8)	55.681	.60	3.95	1.08	2.84	1.10	.16	8.84
March...	(7x8)	88.860	.60	3.79	1.11	2.46	.47	.14	7.97
April....	(7x8)	18.991	.60	3.50	.90	2.35	......	.11	6.86
May......	(7x8)	54.506	.60	3.73	1.02	2.65	......	.13	7.51
June.....	(7x8)	84.304	.60	3.22	1.33	2.48	.55	.13	7.71
		409.947	.60	3.61	1.12	2.67	.42	.14	7.96

CREOSOTED TIMBER.

THE NORFOLK CREOSOTING COMPANY'S METHOD OF PRESERVING WOOD FROM MOLLUSKS AND THE ELEMENTS.

The preservation of timber by the Dead Oil of Coal Tar process, as carried on by all well-equipped creosoting plants, consists of two distinct operations —the preparation of the wood, and its impregnation with the preservative. The preparation of the wood necessary for the proper reception of the preserving substances is the removal of all those portions of the tissue which are subject to fermentative action. This consists of the extraction of the liquids and semi-liquids occupying the interfibrous spaces, and constituting the very immature portions of the wood, without softening the cement binding of the febrillæ, or bundles of cellulose tissue, forming the solid or fully matured part. Upon the successful accomplishment of this entirely depends the value of artificially preserved wood for structural purposes. If this step of the operation is conducted at too low a temperature, or for too short a time, the sap or liquid part nearest the surface will only be extracted, the consequence of which will be an insufficient space for receiving the preservative. If, on the other hand, the operation is carried on at too high a temperature, or for too long a time, the resinous portion of the bundles of fibrillæ will be softened and the wood lose its elasticity in just the proportion that the coherence of the fibrillæ is lessened. The temperature should never be less than 100° C. or exceeding 130° C. Of the two possible methods for the removal of the undesirable portions of the timber, exposure to currents of dry air, and steaming under pressure with an after drying in a vacuum, the latter is now the universal practice. While the first named plan may seem the more rational, and the one least likely to modify injuriously

the physical structure, such is not the case. Under proper manipulation, a more thorough desiccation, without harmful change of the organic structure, can be accomplished in twelve hours less by the latter process, than is ever possible with air drying which, under the most favorable circumstances, is a long-drawn-out operation, and cannot do more than extract the water from that portion of the sap which has not yet reached the semi-solid stage, thus leaving in the tissues of the wood a very considerable amount of resinous matter which occupies space that should be ready to receive the creosote oil. The consequence of this is a failure of the oil to reach many of the interfibrous passages, which are either left empty or are filled with the gelatinous part of the half-matured growth cells in which are to be found the conditions that make putrefaction possible. In order to remove the sap from wood, it is first necessary to vaporize it and then to bring about such external circumstances which shall allow outflow of all gaseous matter from the interior of the wood. In order to vaporize the sap it is necessary to break down the walls of the cells containing the liquid and semi-liquid substances. This is readily accomplished through the agency of heat applied through the medium of a moist steam bath, at such a pressure as to keep the temperature of the wood, and its surrounding atmosphere, somewhat above the boiling point of the sap. The maintenance of this condition for a few hours is found to be quite sufficient to break down the sap-cell tissue and to vaporize all those constituents that it is desirable to withdraw. This point having been reached, the steam bath is discontinued, and the temperature being maintained at, or slightly above, the vaporizing point of the sap, the pressure of the atmosphere surrounding the wood within the chamber is reduced below that of the interior of the wood. The result of this condition is an outflow of vapor and air, continuing until equilibrium is restored. This equilibrium is prevented by the use of an exhaust pump until the ab-

sence of aqueous vapor in the discharge from the pump indicates the completion of the operation. At this stage of wood tissue is in a state very like that of a sponge cleared of hot water; every pore is gaping open and ready to receive the oil.

In the practice of the Norfolk Creosoting Company the most carefully dried lumber is steamed and subjected to the action of the heated "vacuum" in order that there may be had that thorough and uniform penetration of the preserving liquid that is essential to the highest efficiency of the product. The timber having been thus prepared the creosote oil is admitted to the chamber, which is still kept under the influence of the vacuum pump, at a temperature somewhat above the boiling point of the sap, at the pressure then existing in the chamber. As the hot oil envelops the wood and enters the interfibrous spaces, the aqueous vapor yet remaining in the wood, by reason of its less specific gravity, rises to the top of the containing chamber and is withdrawn by the pump. By the time that the chamber is entirely filled with oil, all the remaining moisture has escaped. The exhaust pump is stopped and, in order to facilitate the absorption of the oil by the wood, a pressure pump is set to work supplying oil to the chamber at such pressure as may be desired. This operation is continued until the requisite amount of oil has been put into the timber. The chamber is then opened and the timber withdrawn. The apparatus is then ready for further use.

The successful conduct of the operation above outlined exacts the most careful attention and skillful management, supplemented by adequate and suitable appliances. The wide divergence in the characteristics of timber; the varying amounts of sap, due to the lapse of time since, and the season in which the tree was felled; its possible subsequent immersion in water for a longer or shorter time; the character of the soil and the conditions under which the tree grew, whether in a dense forest or a comparatively open country, whether it is of a rapid even

growth, or a slow intermittent one, are all factors contributing to a more or less perfect product. To the experienced operator these conditions indicate, in each case, the proper course to be pursued. Failure to observe and to take them into consideration is to invite indifferent, uncertain and in the end unsatisfactory results. Of equal importance is a proper understanding of the circumstances under which the finished product is to be used. Timber for piers, wharves and other structures in tropical waters demand processes and degrees of thoroughness of treatment that are unnecessary in the harbors of more temperate climates, which are, in turn, more exacting than land and fresh water construction.

The success of the Dead Oil of Coal Tar process owes its virtue to the presence of insoluble non-volatile substances indifferent to the attacks of oxidation or putrefaction, under the conditions to which its product is normally exposed. Of these substances, by far the most abundant are the Naphthalene compounds which occur in commercial dead oil of coal tar to the extent of from thirty to sixty per cent by weight. Naphthalene proper, the most abundant of the series, is in its pure state a white substance in the form of closely adhering rhomboidal crystals. It fuses at 79° C. and vaporizes at 212-220. Its specific gravity is 0.9778 at its boiling point. It is insoluble in cold water; sparingly so in hot; it is slightly volatile at normal temperatures.

SPECIFICATION FOR CREOSOTED TIMBER.

MATERIALS.—Timber shall be of the dimension specified, straight, free from windshakes, large or loose or decayed knots, red-heart or anything impairing its strength or durability, and to be cut from sound live trees, and to be . . .

OIL.—All oil shall be the heavy or dead oil of coal tar, containing not more than 1½ per cent of water, and not more than 5 per cent of tar, and not more than 5 per cent of carbolic acid.

It must not flash below 185° F. nor burn below 200° F. and it must be fluid at 118° F. It must begin to distill at 320° F. and must yield between that temperature and 410° F. of all substances, less than 20 per cent by volume.

Between 410 and 470° F. the yield of naphthalene must be not less than 40 nor more than 60 per cent by volume. At two degrees above its liquefying point it must have a specific gravity of maximum 1.05 and minimum 1.015.

PROCESSES OF TREATMENT.—Seasoning: This is to be accomplished by subjecting the timber to the action of live steam for a period of from five to seven hours at a pressure of 35 to 55 pounds per square inch, the temperature not at any time exceeding 275° F. unless the timber be water-soaked, in which case it may reach 285° F. for the first half of the period. At the expiration of the steaming the chamber shall be entirely emptied of sap and water by drawing off at the bottom. As soon as the chamber is cleared of all sap and water a vacuum of not less than 20 inches shall be set up and maintained in the chamber, for a period of from five to eight hours, or until the discharge from the vacuum pump has no odor or taste, the temperature in the chamber being maintained at between 100 and 130° F. The chamber being again emptied of all sap and water the oil is to be admitted, the vacuum pump being worked at its full speed until the chamber is filled with oil. As soon thereafter as is practicable such a pressure shall be set up as shall cause the entire charge of timber to absorb . . . pounds of oil within . . . per cent more or less (at a minimum penetration of 1½ inches in round timber for a treatment of 12 pounds of oil per cubic feet, constituting a basis for determining the penetration due to a treatment of any specific quantity of oil) . . . inches from all exposed surfaces. The depth of the penetration being ascertained by boring the treated piece with an auger, making a hole not more than ⅝ inch in diameter, such pieces as are found not to

have the required penetration being returned to the chamber with a subsequent charge for further treatment.

INSPECTION.—Inspection shall be made as the work progresses, and at as early a date as is practicable, in order that there may be a minimum loss of time and materials due to rejections.

The inspector, or other authorized agent of the purchaser, shall have reasonable notice of the intention on the part of the contractor to begin the treatment of a charge of timber, and he shall have at all times during the treatment of the timber under his charge access to the works, and all reasonable and necessary facilities for ascertaining that all the requirements of this specification are complied with. Such "reasonable facilities" providing opportunity, at the proper time, for measuring all timber, treatment-chambers, oil-tanks, etc., and for taking samples of the oil being used, for analysis, as often as he may deem necessary.

NOTE.—All cut ends, mortises, tenons, and other incisions of the original surface of creosoted timber should be protected by not less than four coats of creosote oil, applied boiling hot with a brush or mop. In the case of mooring piles, fender piles, and other timber having the cut end exposed to the weather, the portions so exposed should have, in addition to the creosote oil, a heavy final coat of a paste made of equal parts of unslaked lime and creosote oil, applied hot.

NOTES ON CREOSOTING.

SOUTHERN PACIFIC PROGRAMME.

Naphthalene, requires 170 deg. Fahr. to liquefy. Spec. Grav. at 60 deg.—1.050 Be.

Programme.

(1) Vacuum 24 inches ten minutes.

(2) Steam to temp. 125 deg. Fahr., 15 to 20 minutes.

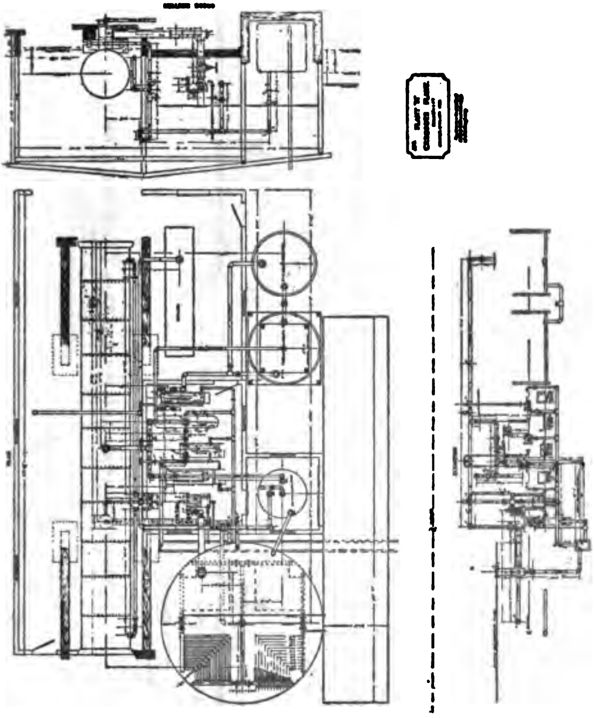


FIG 49—CREOSOTE PLANT

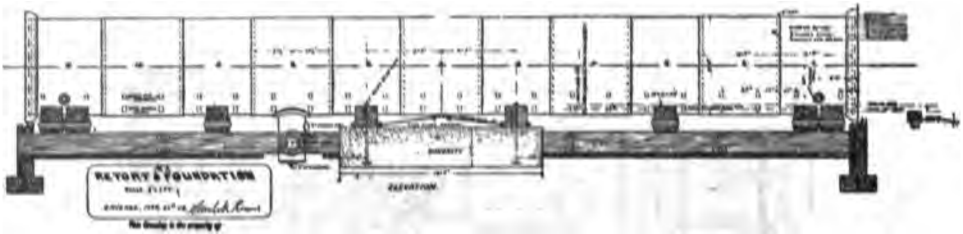


FIG. 50—RETORT AND FOUNDATION (DOOR EACH END).

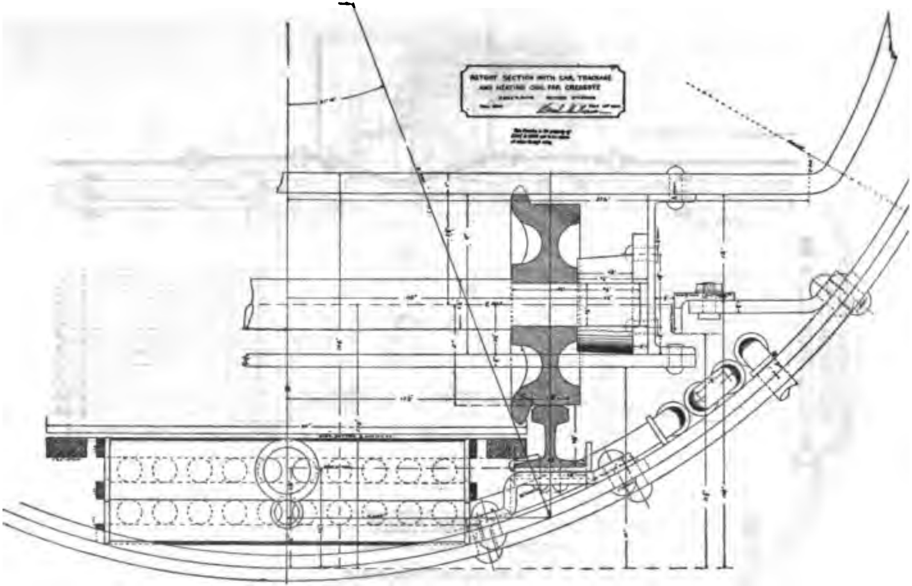


FIG. 51—RETORT SECTION WITH CAR, TRACKAGE AND STEAM COIL FOR CREOSOTING.

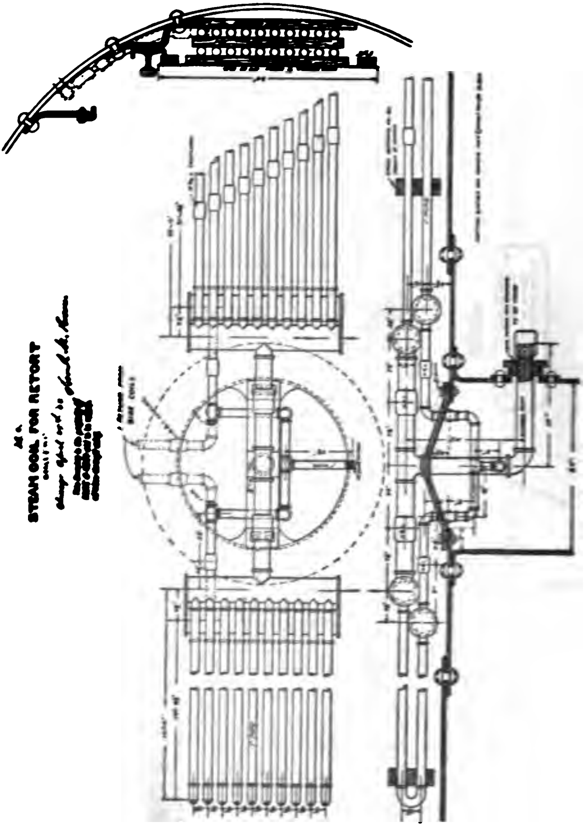


FIG. 52.—STEAM COIL FOR RETORT.

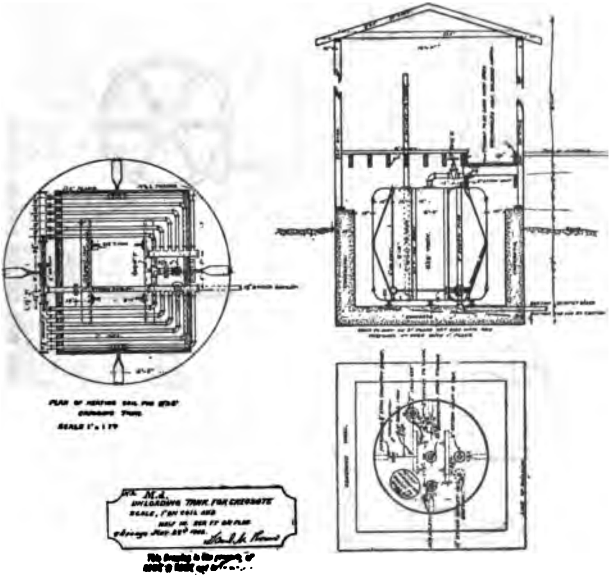


FIG. 53—UNLOADING TANK FOR CREOSOTE

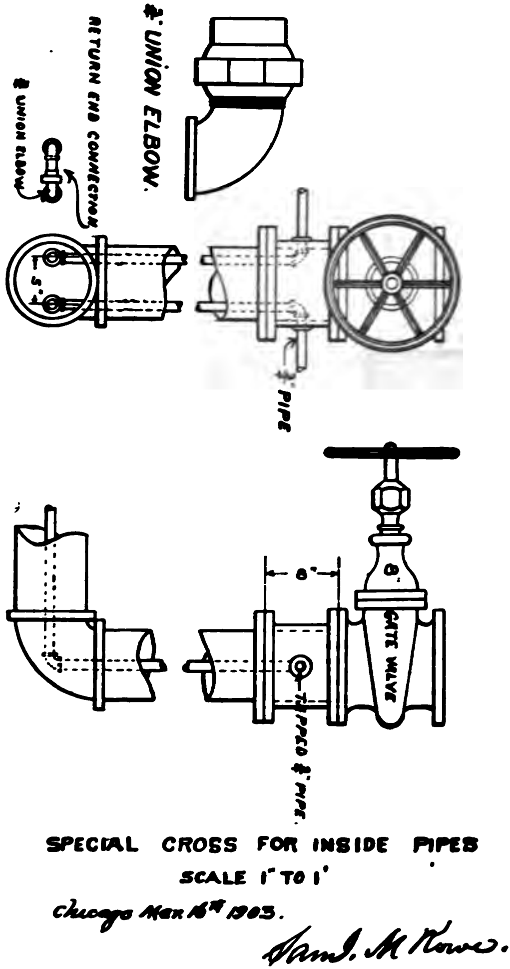


FIG. 54—SPECIAL CROSS FOR INSIDE STEAM PIPES.

(3) Vacuum, 15 to 20 minutes.

(4) Live steam at 30 lbs., 40 minutes, and kept up five (5) hours, temp. not above 250 deg. Fahr.

(5) Blow off steam, 40 minutes.

(6) Third vacuum to 24 to 26 inches for 90 minutes.

(7) Introduce creosote oil at 170 deg. Fahr. and hold at 100 lbs. two hours.

(8) Then force back and withdraw charge. Charge requiring about 11 hours to complete, including introduction and removal of charge.

Notes.—The Great Northern Railway of Ireland requires temperature of oil to be 120 deg. Fahr. and to be held under pressure of 100 lbs. for three hours.

RECORD OF CREOSOTING SOUTHERN PACIFIC RY.

The table given on the following page is compiled by John D. Isaacs, C. E. Engineer of Maintenance of Way of the Southern Pacific Railway. The table is a volume in itself in the way of valuable and authoritative information. The absorption of 1.15 gallons to 1.18 gallons is equal to about ten pounds to the cubic foot and $15.96 to $17.38 per M. B. M. is about 19 to 20 cents per cubic foot. Taking the mean, 20 cents, a 6″x8″ 8-foot tie would cost 53.4 cents and an average tie of 3.2 cubic feet, 64 cents each.

Statement Showing Cost of Creosoting Material at the Southern Pacific Company Wood Preserving Works for the Year Ending June 30, 1902.

At Oakland, Cal.

Months 1901-1902.	Ft. B. M. Treated.	Absorption Per Cubic Ft. Gals.	Cost of Treatment per 1,000 Ft. B. M.—In Dollars. Oil.	Fuel.	Labor.	Mainte-nance.	Oil waste and Water.	Total.
July.....	829,128	1.15	13.45	.75	1.62	.12	.05	15.97
August..	392,580	1.12	12.34	.08	1.67	.66	.03	15.68
Sept	112,236	1.15	12.68	.78	2.10	.26	.06	19.88
October..	Not in	operati	on					
Nov......	545,160	1.15	12.56	.71	1.68	1.42	.05	16.42
Dec......	912,792	1.13	12.27	.73	1.43	.24	.04	14.71
Jan. 1902.	839,964	1.15	2·47	.72	1.37	.69	.05	15.30
Feby	Not in	operati	on					
March...	Not in	operati	on					
April....	478,476	1.15	12.45	.87	1.94	1.91	.08	17.25
May......	98,760	1.15	13.19	.65	1.23	5.17	.12	20.36
June	Not in	operati	on					
Total....	4210,116	1.15	12.63	.77	1.60	.91	.05	15.96
At Latha	*m, Ore.*							
June, '02.	206,613	1.18	12.83	.61	3.90	.01	.02	17.38

RUTGER PROCESS.

ZINC CREOSOTE PROCESS.

Impregnation with Chloride of Zinc solution with an Admixture of Tar Oil Containing Carbolic Acid, According to a Process Invented and Introduced by Julius Rutgers.

The process consists of three operations:

1. Steaming the timber.
2. Producing a vacuum and admitting the preserving fluid.
3. The application of the pressure pump.

The impregnation is to be carried on by exactly the same process as prescribed for the chloride of zinc solution alone, in the preceding part A of this specification. The same conditions will obtain concerning the composition of the chloride of zinc solution and guarantee for the absorption of the preserving fluid. While the chloride of zinc solution is being heated, an amount of 2 kg. of tar oil shall be added to the solution for each tie of a length of 2.50 m. and over, or 20 kg. tar oil for each cubic meter of timber.

The mixing of tar oil with chloride of zinc solution shall be done by means of an efficient mechanical device, and a jet of steam and air.

COMPOSITION OF THE TAR OIL TO BE USED.

The tar oil must contain not more than one per cent of oils that boil below 125 deg. C. (257 deg. F.).

The boiling point of the tar oil as a whole must lie between 150 deg. and 400 deg. Celsius (302 and 752 deg. F.) and not more than 25 per cent must become volatile below 235 deg. Celsius (455 deg. F.).

At least 20 to 25 per cent of its constituents must be acids dissolving in caustic soda lye of 1.15 spec. grav. (oils of the creosote or carbolic acid type).

At 15 deg. Celsius (59 deg. F.) the tar oil must be completely fluid and must be free as possible from naphthalene, so that when distilled in glass vessels, in groups of 50 degrees each (fractional distillation), it should give off not more than 5 per cent of naphthalene. The specific gravity of the tar oil at 15 deg. Celsius (59 deg. F.) must lie between 1.020 and 1.055.

O. Chanute, M. W. S. E. March 21, 1900.

"CREOSOTING" BY JULIUS RUTGERS.

Impregnation with Heated Dead Oil of Tar Containing Carbolic Acid, According to a Process Invented and Introduced by Julius Rutgers.

The treatment consists of two parts:

1. The drying of the timber—i. e., withdrawing the moisture from the wood by means of heated oil of tar and the action of an air pump.

2. Pressing the oil of tar into the wood by means of a pressure pump.

I. DRYING THE TIMBER.

The timber to be impregnated is introduced into the impregnating cylinder which is then hermetically sealed. A vacuum of 60 cm. (23.6 in.) of mercury is then produced and kept up for 10 minutes. The oil of tar, previously heated, is then introduced into the cylinder, to such a height that it cannot be "sucked over" by the air pump, the vacuum being continuously maintained.

The admission of the heated oil of tar is completed at a single operation or with interruptions, according to the dryness of the timber.

During or subsequent to the filling, the oil of tar in the cylinder is heated to a temperature of not less than 105 deg. C. (221 deg. F.) and not more than 115 deg. C. (239 deg. F.) by means of steam, using a coil lying in the lower part of the impregnating cylinder, or a tubular boiler placed underneath. This heating should occupy a period of at least three

hours. After the required temperature is reached in the cylinder it must be kept up for a further period of 60 minutes, either with or without a vacuum, according as it may be necessary in order to ensure the absorption of the specified amount of oil of tar.

As soon as the filling of the impregnating cylinder with heated oil of tar begins, it must be connected with the condenser, which serves to condense all the aqueous vapors that escape from the wood and to conduct all the water of condensation into a vessel intended to receive it. This vessel is provided with a water gauge on which the amount of water evaporated may be read off.

II. PRESSING IN OF THE OIL OF TAR.

After the drying of the wood—i. e., the removal of water from the wood is completed—the tank is filled completely and a pump is put into operation which will produce a pressure of at least 7 atmospheres (103 lbs. per sq. in.). This pressure must be kept up at least 30 minutes for pine or beech wood and 60 minutes for oak, or longer time if it shall prove necessary, in order to insure the absorption of the specified quantity of oil of tar.

This completes the impregnation of the timber and the oil of tar is then drawn off.

COMPOSITION OF THE OIL OF TAR.

The oil of tar must be made from mineral coal tar and must contain not over one per cent of oils that boil below 125 deg. C. (257 deg. F.). The boiling point of the oil of tar as a whole must lie between 150 deg. and 400 deg. C. (302 and 752 deg. F.), and the larger part of it, at least 75 per cent of the whole, must not boil below 235 deg. C. (455 deg. F.).

At least 10 per cent of its constituents must be acid dissolving in caustic soda lye of 1.15 sp. gr. (Oils of the creosote or carbolic acid type.)

At 15 deg. C. (59 deg. F.) the oil of tar must be

completely fluid and free from fatty constituents, so that when poured out on the dry end surface of a timber it will soak into the wood immediately and leave only an oily residue. It must further be free as possible from naphthalene and at 15 deg. C. (59 deg. F.) must give off no naphthalene.

It must contain no oil of specific gravity less than 0.9 (or at least not over one per cent of such oils), while the specific gravity of the tar oil itself at 15 deg. C. (59 deg. F.) must lie between 1.045 and 1.10.

It must also be of such consistency that it is retained in the pores of the timber as much as possible after impregnation. Oils made from bituminous substances may be added to the mineral tar oil to an amount not exceeding 15 per cent, but the mixture must possess the same properties as are specified above for mineral tar oil.

O. Chanute, M. W. S. E. March 21, 1900.

THE RUPING PROCESS.

EMULSIONS OF TAR OIL.

Owing to the fact that tar impregnation is far the best, but that its general use is prevented by its high price, trials have been made with the view of making the process cheaper.

These trials are based on the undoubtedly correct opinion that, considering the high antiseptic qualities of tar, only minor quantities would be sufficient to protect wood against decay in all its parts capable of impregnation.

The trials began with the object of introducing vaporized tar into the wood, but they failed merely because tar oil vaporizes at from 250 to 300 centigrades of heat. Wood being unable to stand such a high temperature and because the vapor condenses on the outer layers of the wood.

Therefore the trials were changed inasmuch as the tar was thinned—i. e., diluted with water.

At the same time two methods have been proposed in this respect.

According to the first, the wood is impregnated in a tar-oil emulsion obtained by mixing the tar-oil with a watery solution of resinous soap. The water of the emulsion is later removed from the wood by drying, the other ingredients remaining in it. In this emulsion the tar is distributed into innumerable globulets enclosed in soap, and by this means prevented from reuniting. But the tar enclosed in this manner is hardly able to come in direct contact with the walls of the cells and therefore cannot produce its high antiseptic effect.

According to the other method resinous oil is treated with concentrated sulphuric acid and the produce obtained in this manner is used as a dissolving means for the tar-oil, which then can be mixed with water. But this is questionable, whether the acid has not so bad effect on the tar-oil that the latter loses its quality as a first-class antiseptic.

Both the processes, however, have a common fault.

In thus impregnating wood, water is the only ingredient of the emulsion that penetrates into all parts capable of impregnation, not the tar itself. The globules of tar can on certain places only penetrate a few centimeters into it, owing to the filtering capabilities of the wood.

How powerful the filtering qualities of wood are can be seen by the fact that it is capable of separating the salts from salt solutions, which is all the more surprising because there does not exist any salt in concrete particles, as is the case with emulsions. This quality of wood has been applied in trials to make water drinkable by pressing it through wood.

Under these circumstances it should be clear to anybody that, as already mentioned, in impregnating with an emulsion the particles of tar are already kept back by the upper layers of the wood and

that consequently only the water can penetrate into the interior of it.

THE PROCESS.

According to the previous explanation a practical, lasting and at the same time cheap preservation of wood, especially of railway sleepers, telegraph poles and mining timber, can be effected neither by the noted metallic salt impregnation nor by the above mentioned tar impregnation. Knowing this, our firm tried to solve the problem by another way and after many attempts of the kind, our partner, M. Ruping—owing to the encouragement of Geheimer Postrat Christiani—finally succeeded in inventing a method of tar impregnation, which is exempt from the faults of the other methods.

Whilst by the former methods of tar impregnation the cells, pores and other cavities are entirely filled with tar, in consequence of which it may be called full-cell tar impregnation, or for shortness, full cell impregnation, our process is devised to do exactly the reverse.

The cells are intended to remain more or less empty, just as is wanted, and only their walls are to be coated or impregnated with tar-oil, a process which can be called empty cell tar impregnation, or, for shortness, empty cell impregnation.

Before entering upon the explanation of this new process we ought to shortly mention the usual tar impregnation in order to explain more definitely the differences between the two processes.

In the so-called full cell impregnation the wood, after drying in the open air, is put into an iron boiler, which has to be made a vacuum, so that even the air enclosed in the cells of the wood be removed. Then the tar-oil is caused to enter the impregnating boiler, and afterward the fluid is kept under a pressure of from 5 to 8 atmospheres, by which means it will be forced into the cells of the wood. Finally the pressure is taken away and

after removing the unabsorbed tar remaining in the boiler the process of impregnation is finished.

In the new Ruping process the seasoned wood is for some time (from about a half hour to an hour) exposed to a pressure of 5 atmospheres in the boiler —F—so that all the cells must be filled with air.

This is the principal difference between the old and the new method: with the former the air was removed from the wood cells by vacuum, whereas on the contrary with the latter, the wood is filled with compressed air.

Without reducing the pressure in the impregnating boiler F, the warmed impregnating fluid is then forced from the tar reservoir T into the impregnating boiler F by means of a somewhat higher pressure, say of about 5½ atmospheres. In proportion to the amount of tar entering the impregnating boiler F, air is permitted to escape through the valve V, in order to make room for the required amount of fluid. At the same time, however, it must be kept in mind only to let such a quantity of air escape as cannot impair the consistency of the pressure of 5 atmospheres.

When the wood in the boiler F is completely covered with the fluid, the pressure, according to the dimensions and qualities of the material, is to be increased up to 15 atmospheres. Under this increased pressure the fluid will enter into the cells of the wood.

Now, one should believe that though the violent advancing of the fluid (in this case of the tar) the compressed air contained in the wood must be forced into the interior of it and there form a kind of basin which would render an impregnation of this part impossible, but this, according to trials made on a large scale, has proved not to be true. Owing to the high pressure, the tar-oil, in consequence of the capalarity of the wood and the adhesion, moves along the cell walls into the inmost parts of the wood, soaking them entirely, by which the compressed air contained in the cells will be

more compressed and at the same time entirely enclosed by the advancing tar.

When the material is sufficiently impregnated, the pressure is to be reduced and the fluid is permitted to go back into the reservoir T.

The compressed air enclosed in the cells will, with great energy, through its expansion, force as much of the impregnating fluid out of the wood as does not stick to the cell walls.

This is what forms the principal effect in the Ruping process.

Accordingly there can remain no more fluid in the wood than is exactly necessary for impregnating or coating and soaking the cell walls, etc., which is the only important object in view in the preservation of wood.

The oozing of the superfluous tar can be still increased and accelerated by exposing the impregnated wood to the effects of a vacuum for some time. Of course, in each case the pressure can be fixed in such a way that only the quantity of fluid, which is wanted, remains in the cells of the impregnated wood.

Refer to "The Ruping Process," by Mr. M. Ruping. Patented in Germany, No. 138,933; patented in England, No. 6844; patented in U. S. A., No. 709,799.

THE HASSELMANN PROCESS.

COST OF CHANGING BARNETT PLANT TO USE THE SYSTEM.

First, and most important in cost, will be two large bricked and plastered cisterns to hold the solution used. These cisterns should be 20 feet in diameter in the clear and 8 feet deep, with plank covering about at level of the ground. These could be placed outside the rear of the building and will have to be connected with the retort to be used for the purpose, by a system of ample large pipe by which the solutions will be quickly conveyed back and forth.

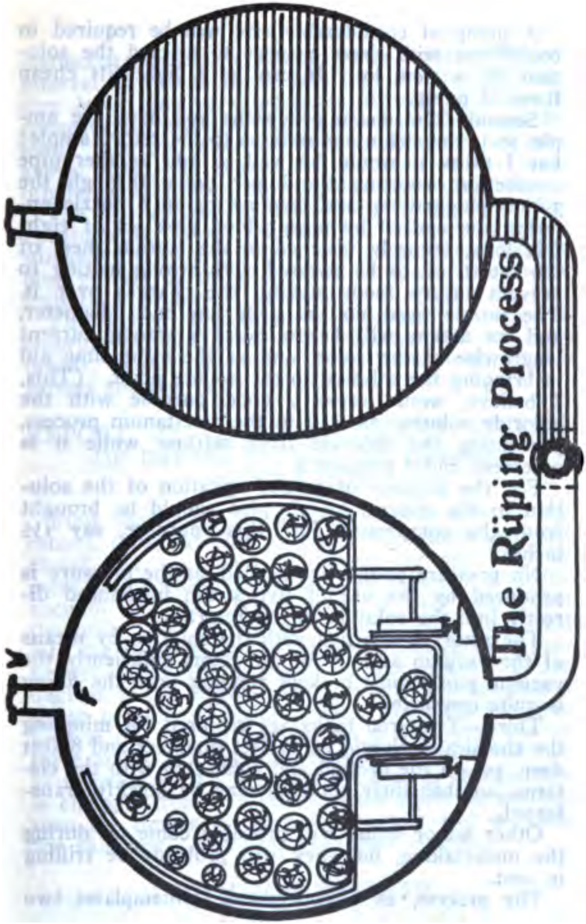


FIG. 64—THE RUPING PROCESS.

A pump of considerable size will be required in connection with these cisterns to discard the solution for a new lot. It can be a light lift cheap form of pump.

Second—The steam provisions you have are ample, so is the steam connections to the retort, ample; but I think it would be well to add another pipe connection, entering the lower dome through the 3-foot plugged tap and terminating in a nozzle entering the end of an open 3-foot pipe six or eight feet long, securely fastened to the bottom sheet of the retort, all to be covered with strong netting to prevent injury from moving the charges over it. The nozzle need not be over one inch diameter, and its action will be to cause a strong current lengthwise of the retort and at the same time aid in bringing the solution to the boiling point. (This, I believe, would serve a good purpose with the chloride solution as well in the zinc-tannin process, preventing the chloride from settling while it is quiescent under pressure.)

For the purpose of proper agitation of the solution in the cistern, an air pipe should be brought from the compressor for this purpose, say 1½ inches.

No pressure pumps are needed, as the pressure is produced by the use of live steam introduced directly into the solution in the retort.

The retort is charged with the solution by means of the vacuum and to fill the retort sufficiently the vacuum pump must be kept running until the filling is quite complete.

Third—Two iron tanks are required for mingling the chemicals; should be 10 feet diameter and 8 feet deep, set on the ground and connected with the cisterns, so that their contents may be quickly transferred.

Other minor items will probably come up during the undertaking, but they will probably be trifling in cost.

The process, as I understand, contemplates two

distinct treatments or boilings to be separated by an interval of two to three days that the first application have time to disseminate through the piece; consequently eight or ten runs of the first can be made, then the other can follow. If plenty of cars are at hand, the charge can be held on the cars, otherwise they must be unloaded and reloaded.

The first application consists of the salts of iron (presumably Fe-2), sulphate of aluminum (presumably alum.) and sulphate of copper (presumably blue vitriol), in the proportion of one of the chemicals to 30 of water (presumably in weight).

The second application is composed of calcium chloride (Calc-2) and milk of lime (calcium hydrate), in the proportion of one pint to 50 of the former and one to 40 of the latter.

REPORT OF THE HASSELMANN SYSTEM OF IMPREGNATION OF TIMBER.

OPERATION.

First, the timber is loaded on cars and put in the retorts, same as other systems; the retorts are then closed and a vacuum is pumped for one hour or more; after which the solution is turned in with the vacuum still on. When retort is very near filled the main valve is closed, and live steam is turned into the solution and distributed through by a perforated pipe; the solution is then heated to 245 degrees to 260 degrees Fahr., which will indicate a gauge pressure of about 35 lbs. The timber is then held in this boiling solution for a time from two to three hours, and then the solution is drawn off; or, as in practice, Mr. Weinier, the man in charge, says is changed from one retort to the other in waiting, then the timber is taken from retort and is ready for shipment. The process is very simple.

SOLUTION OF BATH.

Is a mixture of one and one-half per cent solu-

tion of sulphate of copper, a one-half per cent solution of sulphate of aluminum, and potassium of sulphate, in proportion accordingly to the condition of the timber, which seems to be one of the secrets of the system.

"THE CREO-RESINATE PROCESS."

This process* differs from the ordinary creosoting process in that instead of using live steam to sterilize the blocks, which are 4 by 4 by 8 inches, dry heat applied at a temperature of 250 degrees Fahrenheit, and under pressure of one hundred pounds to the square inch is used. The air pressure prevents the checking of the block, and the heat and pressure are held until the center of the blocks reaches 212 degrees, thereby destroying all germ life in the timber, which is the primary cause of decay. The heat is then reduced to 150 degrees, after which a vacuum of 26 inches is created, under which the cylinder is run full of creo-resinate mixture, which consists of 50 per cent creosote oil, 48 per cent resin and 2 per cent formaldehyde. Pressure is then applied by means of force pumps, and the mixture is forced into the blocks until every pore is penetrated and 22 pounds per cubic foot of the mixture is absorbed. The blocks are then run into another cylinder and treated with a solution of lime at a temperature of 212 degrees, and under pressure of 150 pounds to the square inch. They are allowed to cool off gradually, and are then ready for market.

NOTE.—The author has examined specimens of paving blocks treated by this process and would think it a very good process for paving blocks. No information as to mode or cost of treating has been obtained.

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*Controlled and used by the United States Wood Preserving Company, New York.

THE VALUE OF TREATMENT OF TIMBER

It is our desire here to give a conservative view, as we in searching for the truth can hardly afford to deceive ourselves or the interested public and those especially concerned. On the other hand, it would be equally foolish to depreciate results when we have the means to arrive at what is demonstrated as probably near the truth; as near as human intellect can discern and near enough to be accepted as practically true.

What is here advanced is the summing up of observations and study of the subject. This investigation has required many months of close study, during which the closest and most searching analysis of the recorded results with the various collateral influences, have been considered and allowed for. To the management of the A. T. & S. F. Railway Company is due the highest degree of credit for the careful and comprehensive record that has been kept and to this in a great measure is due the conclusion now proposed to be given. The record here dealt with closes with the record of 1902, none later being available, seventeen years from the start in 1885, an elapse of time sufficient to give something sufficiently definite on which to base measurably reliable conclusions. Unfortunately the record of tie removals was not taken up until 1897, twelve years after the first ties were treated, so that the number of ties failing during that interval will necessarily have to be estimated.

The removals of ties treated in the years subsequent to 1897, down to 1900, however, will give us an approximate rate of removal in the earlier years that will guide somewhat. By means of this record a close approximate is made of the percentage of the treated ties removed each year. We take it for granted that measurably correct conclusions can be derived from the mean of a large number of results for the same

lapse of time, and further, that causes acting as does the decay of timber under similar conditions, in various periods during its history will, if graphically recorded, form a curve. In line with this we have first laid down a line showing the percentage of ties removed each year, being the mean for all the years recorded, that portion not covered by the record being derived from the mean of removals in the early years of those subsequently treated. The bottom line of the table shows the percentages so derived, and the curved line "a" on the diagram the same graphically disposed.

We find, however, that according to this the ties treated in 1885 should have been exhausted in the seventeenth year, while it has been found by somewhat extended inspection that many of the 1885 ties are still in service and good for many years longer. There are probably 20,000 of these ties in yet, certainly 15,000, hence we are obliged to reduce the estimated percentages for the earlier years where we have no record, and apply it to the 1885 ties alone, as shown by the line "b" on the diagram. A careful and extended inspection of the condition of all the ties so far as extended shows that those treated in the earlier years are giving a better record than most of the subsequent years, so far as now determined. It is not for me to say here what are the reasons, but the result as shown in the present conditions of the ties of the various years is patent. The 1885 ties and those treated in the three or four years subsequent (1886, 1887 and 1888) are almost identical in general appearance, with condition as to soundness almost in the same ratio, and can safely be expected to give a record eventually about equal to those of 1885. They are characterized by the manner in which decay progresses, commencing at the surface in contact with the earth, and continuing, the fiber being destroyed regularly in succession as it passes upward, leaving many of those ties now fourteen to seventeen years' service, with almost half of its timber sound enough to make good fuel.

Those of subsequent years show that decay spreads through the body of the tie at a much earlier period.

Whether this is due to poorer quality of timber, leaving the timber on the ground without being piled to dry, or to improper or hasty treatment, cannot now be said. The two former are the most probable causes, however.

That the results here shown by these earlier treated ties should be taken as a sample of what can be done seems reasonable. All but a few of these ties were treated by the "Wellhouse" or Zinc-tannin process, and have given a record that should not have been lowered in subsequent treatment. Here we have up to 1900 enough treated ties to lay 1,883 miles of track, 3,872,500 ties treated, removals in same time at an average of 8 year or 11,000 *year miles*, equal to 961,654 ties, or 87.4 ties per annum per mile, the mean number of ties removed in ordinary practice being from 250 to 300 where ordinary run of ties is used.

In this tabulation all ties removed, whether on account of decay or of breakage from derailments or from premature removal in relaying rails or in ballasting are included. It is well known in practice that many ties that may still serve for several years are, after being disturbed by relaying rails or in ballasting, removed to give place to new ties. The proportion of removals for other causes than decay is estimated at not less than five per cent and may be as high as ten per cent, but as this loss is common in all cases, it is deemed best not to consider this in connection with this matter, but to include them all in this estimate.

Right here it will be proper to survey the subject of inspection with reference to the "personal equation," that effect that creates a variety of impressions almost as varied as the number of observers. The writer believes that the searcher must trust to extended and repeated observation until the mind has absorbed and assimilated every aspect of the subject so that instinct is trained, as it often becomes, in, for instance, the recognition of the great variety of timbers, as often occurs with experienced lumbermen, in which case he can unerringly name each variety without being able to put this description into words.

This is found to be equally true in recognizing the various conditions shown during the years of exposure by the ties in track. Verifying this is the corroborating experience of others, who have aided much in this investigation.

In making the recent inspection of the Santa Fe it was found that Mr. Daniel Elliott, the roadmaster who had been on his division ever since a short time previous to the commencement of using the treated ties, could walk along the track and almost invariably name the year the tie was treated without looking at the brand of the stamping hammer. On the other hand, a large majority of those that had equally good opportunity to observe could see little or no difference between one and another. In one case a section foreman who confessed to have been engaged on a section for over ten years, where treated ties were in the track from some previous year, to the extent of twenty-five per cent, was unaware of their presence and could tell nothing as to their value compared with cedar ties along side of them, which were cut one-quarter of the depth by the rail, while the treated ties were almost invariably sound and but little rail-worn. We thus can easily conceive how the value of the results can be beclouded by lack of careful intelligent study.

In the inspection of treated ties care has been taken to gather all the information possible from those treated by the same process outside of that on the Atchison, Topeka and Santa Fe Railway. Those treated at Chicago by the Chicago Tie Works and distributed on various portions of the Chicago, Rock Island and Pacific, some of which have been in service for fifteen to seventeen years, the result seems to be equally good as those on the Santa Fe. The methods used in treatment are essentially the same as those introduced at Las Vegas in 1885, and it is believed will make just as good a showing. Some samples of treated hemlock on the C. R. I. & P. and also in the Rock Island and Peoria Railroad with a number of samples from the A. T. & S. F. were exhibited at the last spring meeting of the American

Railway Engineers and Maintenance of Way Association in which the fiber of the timber was still sound at fourteen to sixteen years.

The treatment of Texas pine commenced in 1897. After six years of exposure, some begin to show decay, but this is mainly confined to the lowland short leaf pine (Loblolly). A careful inspection of two miles of the Dallas branch showed one in sixty of these ties to be decayed so as to justify removal. The roadmaster, however, thinks that a much larger proportion are failing. It is, however, too early to draw anything like definite conclusions in this case. The climatic conditions there are not so favorable as in New Mexico or Colorado. Ties made from this kind of timber in Eastern Texas have been known to rot so as to be worthless in two years and not one in a thousand fit to put in track in three years.

On the same line at six years, the treated ties which were cut from heart timber or well matured trees were very much better than the Loblolly pole ties before mentioned. It will be seen that a small percentage of the treated ties in New Mexico give out in the sixth year and scarcely any before that, while from the recent inspection some of the 1885 ties will be in service from appearance up to nearly twenty-four years.

The value of the treatment by the "Wellhouse" process must be conceded, taking such records as are now available both as to this process and that of the Burnett or simple chloride of zinc, to be the best probably in proportion of near twelve years for the former and eight years for the latter, or fifty per cent in favor of the former. It must, however, be remembered that the statistics are also subject to the "human (not personal) equation" and that it may be years before this question can be settled, but, to go back to the main question of the economic value of either; the one's relation to the other, depending as it does somewhat on climatic conditions may be indeterminate for the present.

Whether it is determined or not, the reduction of renewals from "twenty-five per cent to five," as once

stated by a railroad official who has been in a position all the time to judge as well as anybody living, even if proved to be too sanguine, which it does not appear to be at the present time, and in view of the foregoing figures, should go far to settle the question of economy.

The renewals now seem to be under four per cent, or about 100 ties per mile per year. It is, however, a fact that the untreated mountain pine ties first laid in New Mexico, did come out at the ratio stated and the tie question at that time was such as to appall the management.

The appearance of the treated timber is found to guide somewhat as to the condition as to progress of decay and may guide in determining the reasons of failure, whether due to failure to carry out the proper treatment or to other causes.

As before stated, the 1885 to 1888 ties are characterized by a certain freedom from longitudinal and end checks, while those of subsequent years have the checking quite marked, giving the tie the appearance of being split into many strips. When these ties are taken out they go into strips sure enough. Another feature is the manner in which the decay progresses. A case in point will illustrate the way that decay progressed in the 1885–1888 ties. A large number of these ties after three years in track in one marked case, were broken in two pieces by the engine driver wheel flange in a bad derailment. Examination showed a layer of decayed wood on the bottom and up the side as far as the earth was in contact, about one-quarter of an inch in thickness in which the wood was entirely decayed, the balance of the tie remaining entirely free from appearance of decay, not even incipient. This applied to every tie, nearly a hundred in number.

Quite a number of the ties treated the same year, 1885, or the two or three following years, when removed in the course of the recent renewals after from fourteen to seventeen years' service, showed the same method of progress of decay, i. e., from the bottom upward so that about half of the volume of

the tie was gone, but the remaining upper half was still sound enough for good fuel.

Ties treated in some of the subsequent years showed decay permeating the body of the tie irregularly and the tie when removed would go all to pieces.

The mean life is that which represents the sum of the life of all divided by the number, and this method is here used and is evidently the only practical measure.

Perhaps the best illustration of this manner of progress of decay will be the facts as they occur.

The year in which the ties are put in the track is the starting point. The year in which the first ties fail is another step, the rate from there on is the curve of failure and the year at which the last are removed is the culmination. It is here attempted to place a close approximate value to these various terms. If every piece was exactly alike in texture, density or soundness, all should fail at once, but this is never so. It would be very interesting to know what the curve representing the life of the untreated timber of various kinds really is. This so far seems never to have been recorded so far as we know, and here is a difficulty we encounter when comparing the treated ties with the same untreated. The life of the Rocky Mountain pine has been variously estimated at from a mean of from five years down to four or even below, and the fact, according to some of those best versed, is that four and a half years is about right. Then if the "Wellhouse" treatment gives a mean of near twelve years, we have nearly trebled the life. Mr. Elliott is quite sure that this estimate is a conservative one, and the figures so far indicate nearer fourteen years than twelve.

The Wellhouse process, it is claimed, derives its advantage over the simple chloride of zinc (Burnett) process, in this, that the leatheroid produced on the surface and in the end pores of the wood by the combination of the glue and the tannic acid retards the ingress of water. That it does so seems to be quite well authenticated.

In the simple process of immersing one sample

block of wood after being treated and a similar block say from the same tie without treating will corroborate this, it being found that the untreated block will at first absorb the water the most rapidly, although eventually the treated block will absorb the most. The latter effect seems to be due to physical changes in the wood during treatment, the solubles in the timber having been dissolved and removed by the cooking.

Critics claim that the deposit of the glue is so superficial that it cannot do much good. It is true that owing to the viscosity of the glue it cannot penetrate the wood to any appreciable depth on the sides, but yet it does penetrate to a considerable depth at the ends by means of the sap ducts. It is the result that justifies its use, however, after all, and no specious theorizing can upset the facts.

The writer has felt it a duty to embody the result of observation and study of this matter of timber preservation, using the utmost candor, giving facts as they seem to be well authenticated.

Time and further experience may show some of these conclusions to be fallacious and as regards the figures given and the resulting conclusions and deductions may prove sanguine but what the figures say cannot be gainsaid without future data only to be gained by the lapse of time. For instance the figures seem to show that the mean life of the treated ties shown might be twenty years.

This is, however, not conclusive as the next few years may necessitate as much greater renewal of ties from causes such as heavier rolling stock, traffic, etc., or by reason of larger renewals due to lax removal previous to this time.

A great many ties may be still in track that should be out or poorer quality of timber may only be available owing to the exhaustion of the supply of the better class of timber. It is most probable that the Santa Fe estimate of eleven to twelve years is a near approach to the true life of the pine tie, although, as Mr. Mudge properly says, the longer mean life of the later renewals will tend to increase the general average.

H.

PER CENT OF TREATED TIES REMOVED—ESTIMATED—"A"																		TOTAL	TIES
No. YEARS, 5. PER CENT OF "A"					1.0%	3.0	7.0	12.5	19.5	28%	37%							"B"	A & B
YEAR	No. TREATED	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th		
1885	111.503										.3340	.1714	.1416	.1075	.0826	.0413	.0528	.5972	.9312
1886	333.298									.3033	.0740	.0544	.0389	.0323	.0155	.0200		.2357	.5384
1887	189.386								.2141	.1206	.1368	.1195	.1192	.0483	.0545			.5999	.8141
1888	285.104							.1364	.0503	.0673	.0715	.0741	.0462	.0382				.3482	.4846
1889	169.174						.0792	.0194	.0357	.0527	.0703	.0418	.0424					.2617	.3409
1890	105.753					.0362	.0380	.0380	.0853	.1070	.0881	.1105						.4663	.4974
1891	128.568				.0148	.0120	.0148	.0456	.0910	.0571	.1084							.3283	.3457
1892	187.270			.0005	.0054	.0284	.0683	.1120	.0940	.1298								.4389	.4394
1893	178.167		.0020	.0020	.0195	.0272	.0717	.0701	.1134									.3039	.3457
1894	247.566	.0007			.0140	.0168	.0308	.0380										.1196	.1203
1895	256.877			.0006	.0075	.0177	.0346											.0604	.0604
1896	336.070			.0016	.0071	.0251												.0338	.0338
1897	380.523		.0006	.0007	.0052													.0062	.0062
1898	350.377	.0002	.0009	.0091														.0102	.0102
1899	460.382	.0007	.0026															.0033	.0033
1900	151.977	.0012																.0012	.0012
TOTALS	3.872.425	PER CENT AS PER REPORTS "B"			1	2	4	5.5	7.0	8.5	9	9	7.75	7	6	5	4.5	76.25	
REDUCED	MEAN %	.0007	.0013	.0030	.0059	.0212	.0432	.0572	.0777	.0892	.0907	.0953	.0777	.0568	.0542	.0306	.0528	76.14	

Chicago Aug. 5th 1903. Saml. M Rowe.

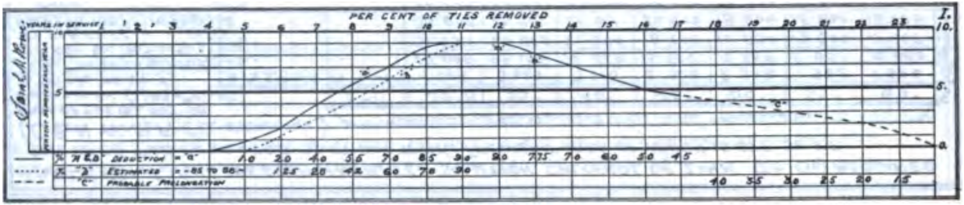

FIG. 68—PER CENT OF TREATED TIES REMOVED.

TABLE -B- CUBIC FEET CONCENTRATED SOLUTION, CHLORIDE OF ZINK ($Zn.Cl_2$) REQUIRED FOR EACH TUB FOOT, FOR 30 FT. DIA. TANK. THE MEAN AREA OF WHICH IS 677 SQ. FT.
(C.&N.W. R.R. CO. ESCANABA)

AREA OF TUB (a), 677' SQ.
WEIGHT OF SOL. (b) 83.4# CU. FT.
% OF SOL. REQ'D (c)
TOTAL # PURE ($Zn\,Cl_2$) REQ'D (e)
STR. CON. SOL. (30 TO 60%) (S)
WT. PER. CU. FT. " " (t)
CU. FT. PR TUB FT. REQ'D (x)

THEN

$$\frac{a \times b \times c}{S \times t} = x.$$

FOR ANY OTHER VALUE OF a, SAY a',

THEN

$$\frac{a'}{a} \times x = x'.$$

x.xt. - LB'S. REQ. FOR SAME CHARGE.

CHICAGO. AUG. 3rd 1903.

[signature]

% STRONG	CU. FT. PR. TUB FT. = "S"	30° B	35°	40°	45°	50°	55°	60°	%
¼ % STRONG		4.504	3.689	3.076	2.600	2.222	1.922	1.666	¼
1½ " "	. . . .	27.028	22.136	18.458	15.602	13.654	11.531	10.000	1½
1¾ " "	. . . .	31.533	25.825	21.534	18.202	15.930	13.826	11.667	1¾
2 " "	. . . .	36.038	29.514	24.611	20.803	18.206	15.861	13.333	2
2¼ " "	. . . .	40.543	33.204	27.687	23.403	20.482	17.777	15.000	2¼
2½ " "	. . . .	45.048	36.893	30.763	26.003	22.759	19.752	16.667	2½
2¾ " "	. . . .	49.552	40.582	33.840	28.640	25.033	21.727	18.334	2¾
3 " "	. . . .	54.057	44.272	36.916	31.204	27.309	23.702	20.000	3
3¼ " "	. . . .	58.562	47.961	39.993	33.804	29.585	25.676	21.677	3¼
3½ " "	. . . .	63.067	51.650	43.069	36.405	31.861	27.658	23.344	3½
3¾ " "	. . . .	67.572	55.340	46.146	39.005	34.137	29.628	25.001	3¾
4 " "	. . . .	72.076	59.029	49.222	41.606	36.412	31.603	26.667	4
4¼ " "	. . . .	76.581	62.718	52.298	44.206	38.688	33.578	28.334	4¼
4½ " "	. . . .	81.087	66.400	55.375	46.580	40.964	35.554	30.001	4½
4¾ " "	. . . .	85.591	70.097	58.451	49.406	43.240	37.529	31.667	4¾
5 " "	. . . .	90.096	73.786	61.528	52.007	45.516	39.504	33.334	5
# CONC. SOL. LB. PR. CU. FT.		75.40	83.70	87.20	91.70	96.80	101.50	107.30	#

THIS IS COMPUTED FOR A WOODEN STAVE TUB, AREA AT .4 OF HEIGHT BY SUBSTITUTING MEAN AREA OF ANY OTHER SIZE TUB (a'). THE TABLE CAN BE COMPUTED IN THE SAME MANNER.
THE TABLE GIVES FOR EACH 5% BETWEEN 30% AND 60%. INTERPOLATE FOR INTERMEDIATES.
TO ESTIMATE FOR VERTICAL FEET NEEDED FROM STORE VAT. DIVIDE THE TABLE QUANTITY BY THE AREA OF THE STORE VAT WHICH WILL GIVE THE VERTICAL FT. REQUIRED.
SHOULD IT BE DESIRED TO WEIGH IN THE SOLUTION, INSTEAD OF MEASURING IT IN VERTICAL FEET OF THE VAT, MULTIPLY THE CUBIC FT. BY THE CORRESPONDING WEIGHT PER CU. FT. = (x t) SEE TABLE "C"

FIG. 80 -TABLE "B" CUBIC FEET CONCENTRATED SOLUTION REQUIRED PER TUB FOOT.

TABLE - C - WEIGHT OF CONCENTRATED SOLUTION, CHLORIDE OF ZINC ($ZN.CL_2$) REQUIRED FOR EACH TUB FT. FOR 30' DIA. TANK. THE MEAN AREA OF WHICH IS 677 SQUARE FEET.

C & N.W.R.R. Co. ESCANABA.

AREA OF TUB (a) 677' SQ.
WT. OF SOL. (b) 63.4# CU'
% SOL. REQ. (c)
TOTAL PURE ZN.CL REQ. (d)
STR. CON. SOL. (30 TO 60%) (s)
WT. PER. CU. FT. " " (t)
CU. FT. PER TUB FT. REQ. (X)
THEN;

$$\frac{a \times b \times c}{s} = Y \text{ LBS}$$

FOR ANY OTHER VALUE OF a SAY a' THEN

$$\frac{a'}{a} \times X = X'$$

X×T = LBS REQ. FOR SAME CHARGE.

CHICAGO. AUG. 5TH 1903.
Saml. M. Rowe.

		Weight of concentrated solution in storage vat.							
	= "a"	30°	35°	40°	45°	50°	55°	60°	%
¼ % STRONG	LBS. PER TUB FT.	358	307	268	238	215	195	179	¼
1½ "	" "	2146	1839	1610	1431	1315	1205	1075	1½
1¾ "	" "	2504	2146	1850	1669	1534	1401	1252	1¾
2 "	" "	2861	2453	2148	1908	1755	1607	1481	2
2¼ "	" "	3219	2759	2404	2146	1972	1801	1610	2¼
2½ "	" "	3577	3066	2683	2484	2192	2001	1788	2½
2¾ "	" "	3934	3372	2951	2626	2511	2201	1967	2¾
3 "	" "	4292	3678	3219	2761	2630	2405	2146	3
3¼ "	" "	4650	3985	3480	3100	2849	2548	2326	3¼
3½ "	" "	5008	4292	3756	3330	3068	2801	2505	3½
3¾ "	" "	5365	4599	4024	3577	3287	3001	2685	3¾
4 "	" "	5723	4905	4292	3815	3506	3201	2857	4
4¼ "	" "	6081	5212	4560	4054	3617	3401	3040	4¼
4½ "	" "	6438	5518	4829	4271	3945	3602	3219	4½
4¾ "	" "	6796	5819	5097	4581	4164	3802	3398	4¾
5 "	" "	7154	6127	5452	4769	4385	4002	3577	5
t. WT. CON. SOL. PER. CU. FT.		79.40	85.10	87.20	91.70	96.30	101.30	107.30	t.

TABLE - C - THIS TABLE GIVES THE NUMBER POUNDS OF STOCK SOLUTION NECESSARY TO STOCK ONE TUB FOOT OF WATER, AND CONTEMPLATES THE USE OF A VAT MOUNTED ON WEIGHING SCALES.

THE SAME EJECTOR USED TO LIFT THE SOLUTION INTO THE TUB WILL FILL AND EMPTY THE VAT, THE SCALE BEAM TIPPING WHEN THE REQUIRED AMOUNT IS PUT IN. FOR AMOUNT OF WATER TOO GREAT FOR VAT TO MEASURE, THE OPERATION CAN BE REPEATED.

FIG. 31—TABLE "C" WEIGHT CONCENTRATED SOLUTION REQUIRED PER TUB FOOT.

NOTES AND EXPLANATIONS.

(a) This, No. 44, is a typical specimen of the Texas Loblolly Pine. The hewn pole ties at Somerville and at Greenville are largely of this character.

(b) No. 55 is short leaf Texas Pine, mostly heart timber, but having what is termed "red heart," a condition in which three or four inches of the timber encircling the heart of the tree has reached a dead and softening condition, in which the spring wood is wasted quite away and the solid layers of the summer wood much impaired. Specifications should and usually do reject timber so affected.

(c) No. 66 is a three-inch section of a New Mexico Mountain Pine, mostly heart timber, which was treated in 1885, the tie being in track over thirteen years and only removed on account of rail wear. At the time it was immersed, it was seemingly as sound and strong as the day it was cut from the tree. It was treated by the Wellhouse process.

(d) No. 32 is cut from the middle of a 38-foot pile, much the same character as No. 44, Loblolly Texas Pine, in which nearly thirty pounds of creosote oil had been injected per cubic foot. Although not immersed for several months after treating, the lighter portions of the oil readily gave place to the water, smearing the surface of the block and floating on the surface of the water.

(e) Nos. 33 and 34 were blocks cut from chord pieces of the Isletta (Atlantic and Pacific Railway) some time after the removal of the bridge, to be replaced by a steel structure, after a service of over twelve years.

The specimens were cut from the end of the chord piece where packed.

This timber was treated after framing and before erecting and was treated by the Wellhouse process.

(f) Nos. 50 and 52 were untreated blocks of southern yellow pine, companion pieces of Nos. 51 and 53, the latter being treated by the Creo-resin process as paving blocks. The same effect of the absorption of the water as in the case of No. 32 (d) the creosote oil and also the resins being forced out during the process. The difference in the specific gravity is probably the measure of the percentage of creosote oil and resin injected into the wood and the difference in the amount of moisture in the blocks at the time of immersion is a means for guessing the amount forced out by the water, although not all, as the surface of the blocks were well smeared over with the exuded resin to such an extent as to render it mere guesswork.

(g) The anomaly of the greater weight of the sap timber over that of heart timber in case of Nos. 26 and 27, is accounted for by the superabundance of resins in No. 27.

(h) Nos. 54 and 56 are specimen blocks of dead pine supposed to have been killed by a peculiar disease or insect. The timber seems strong and sound, but largely discolored, the discoloration being greatest at the outside next the bark and gradually decreasing toward the heart, leaving the latter in some cases perfectly sound. In transverse strength it seems to be unimpaired but under compression lengthwise, its strength is 20 to 30 per cent less than live, sound timber.

– ABSORBENT PROPERTIES OF TIMBERS, WEIGHT &c. –																	(A.)
Ser. No.	Kind of Timber	Where from	Heart or Sap	Weight Per Cu Inch	Weight Per Cu Ft. lbs	Spec. Grav.	Moist. Dr. at Com. % Vol.	Absorption in Vol. 3. Hours	6 Hours	24 Hours	72 Hours	7 Days	14 days	30 days	60 days	Over 6 qd. (6m)	Total at 3 qd. *
04.	Short leaf Pine	Somerville, Tex.	Ht.	.363	39.26	.630	.010	.059	.063	.109	.....	.193	.220	.241	.298	.349	.351
11.	Long leaf Pine	" "	"	.321	34.70	.566	.007	.055	.056	.091	....	.166	.204	.241	.292	.292	.242
22.	Sh. L. Pine	" "	"	.360	32.40	.520	.012	.031	.034	.055	...	.119	.165	.215	.248	.275	.226
33.	" " "	" "	Sap.	.283	30.56	.490	.056	.010	.020	.050	....	.135	.174	.203	.233	.306	.260
44.	" " " (a)	" "	Ht.	.259	27.97	.511	.010	.210	.241	.337	....	.414	.442	.508	.564	.626	.518
56.	" " " (b)	" [illegible]	Ht.	.320	34.50	.554	.013	.053	.063	.107	....	.212	.263	.327	.371	[illegible]	.337
66.	N.M. Pine (c)	Las Vegas.	Ht.	.256	27.64	.443	.016	.049	.054	.081	....	.157	.202	.258	.316	.463	.204
1.	White Pine.	C. M. & St. P. Ry.	Ht.	.196	21.18	.340	N.	....	.048	.068	.109	.180	.245	.269	....	....	.269
2.	" "	[illegible] C.E.	Sap.	.238	25.67	.412	N.	....	.144	.176	.219	.291	.337	.356	....	....	.356
3.	" Cedar.	" " "	Ht.	.204	22.04	.354	N.	....	.055	.081	.113	.181	.224	.274	....	....	.274
4.	" "	" " "	Sap.	.166	17.95	.288	N.	....	.061	.077	.112	.176	.219	.263	....	....	.263
5.	Norway Pine.	" " "	Ht.	.232	25.11	.403	N.	....	.034	.060	.094	.172	.216	.236	....	....	.236
6.	" "	" " "	Sap.	.325	36.07	.563	N.	....	.117	.161	.200	.228	....	.259	....	....	.259
7.	White Oak.	" " "	Ht.	.419	45.27	.726	.020	....	.039	.061	.092	.136	.176	.229	....	...	.249
8.	" "	" " "	Sap.	.433	46.78	.751	N.	....	.050	.077	.113	.163	.208	.270	....	...	.270
9	Tamarack.	" " "	Ht.	.323	35.00	.560	.006	....	.032	.042	.108	.175	.226	.256	....	....	.256
10.	"	" " "	Sap.	.362	39.07	.627	N.	....	.031	.047	.082	.133	.168	.206	....	....	.206
11.	Douglas Fir.	" " "	Ht.	.304	32.85	.527	N.	....	.040	.057	.090	.120	.175	.228	....	....	.228
12.	" " "	" " "	Sap.	.309	33.39	.536	N.	....	.045	.065	.102	.147	.192	.241	....	....	.241
13.	Hemlock.	" " "	Ht.	.247	26.72	.429	.005	....	.103	.122	.183	.265	.324	.374	....	....	.375
14.	"	" " "	Sap.	.228	24.60	.395	N.	....	.098	.118	.167	.222	.260	.273	....	....	.273
15.	Red Oak.	C.M.&St.P.Ry.	Ht.	.318	33.31	.550	N.	....	....	.039	.068	.097	.136	.144	....	....	.144
16	" "	J.N. Barr M.E.	Sap.	.307	33.17	.532	N.	....	....	.054	.073	.101	.132	.143	....	....	.143
17	Hickory, S.B.	" " "	Ht.	.455	49.15	.785	N.	....	....	.058	.078	.101	.134	.137	....	....	.137

FIG. 42—ABSORBENT PROPERTIES OF TIMBER. (A)

ABSORBENT PROPERTIES OF TIMBERS.—WEIGHT %o.																		(B.)
Gen. No.	Kind of Timber	Where From.	Heart or Sap.	Weight. Per Cu. In. Oz.	Weight. Per Cu. Ft. lbs.	Spec. Grav.	Metals at Com. % Vol.	Absorption in Vol.— 3 Hours	6 Hours	24 Hours	72 Hours	7 Days	14 Days.	30 Days.	60 Days	Over 60 ds. (6m)	Total at 30 d. %
18.	Hickory, S.B.	C.M.&St.P.Ry.	Sap	.399	42.96	.691	N.	....	.....	.056	.082	.113	.172	.190	...	....	.190
19.	Sugar Maple.	J.N. Barr M.E.	Both	.407	43.93	.708	N.	....	....	.096	.118	.166	.223	.232	...	....	.232
20.	Bl. Hills Pine.	Bur. & Mo. Ry.	Ht.	.276	29.70	.476	N.	....	....	.063	.111	.143	.169	.204	.257	....	.204
21.	" " "	G.W. Rhodes Supt.	Sap.	.246	26.81	.430	N.	....	...	.112	.138	.161	.179	.201	.265	...	.201
22.	" " "	" "	Ht.	.252	27.24	.437	N.	....	....	.093	.126	.156	.189	.246	.304	....	.246
23.	" " "	" " "	Sap.	.266	28.74	.461	N.	....	....	.096	.145	.180	.220	.265	.319	....	.265
24.	Mountain Pine.	Glorietta Mt.	Sap	.227	24.50	.393	N.	....	....	.141	.179	.184	.204	.278	.371	....	.278
25.	A.T.&S.F. Ry.	" "	Ht.	.255	27.50	.441	N.	....	....	.073	.112	.143	.183	.219	.277	....	.219
26.	Geo. W. Hayes.	Maxwell Gr.	Ht.	.241	26.02	.417	N.	....	....	.079	.124	.151	.183	.239	.335	....	.239
27.	" " " (B)	" "	Sap.	.350	37.83	.607	N.	....	.....	.131	.189	.224	.244	.277	.350	....	.277
28.	" " "	" "	Ht.	.287	31.01	.497	N.	....	....	.083	.118	.143	.176	.217	.257	....	.217
29.	" " "	" "	"	.281	30.40	.488	N.	....	....	.062	.099	.141	.161	.181	.254	....	.181
30.	" " "	" "	Sap.	.225	24.26	.389	N.	....	....	.088	.109	.115	.130	.164	.224	...	.164
31.	Spruce. "	N.M. "	Ht.	.290	31.30	.502	N.	....	....	.048	.091	.118		.164	.224	....	.164
32.	Shtleaf Pine	Somerville	Both	.356	38.45	.617	.009	....	....	.219	.244	.271	.304	.336	.364	....	.336
33.	White Pine (e)	San Marcial	Ht.	.235	25.35	.407	N.	....	.055	.091	.133	...	...	.210	...	...	.210
34.	" " (w)	" "	"	.229	24.71	.396	N.	...	.059	.095	.136	....	....	.272	...	....	.272
35.	Red Spruce.	Col. Midland	Both	.260	28.12	.451	N.	.027	....	.054	....	.169	.221	.274	.317	....	.274
36	" "	By C.N. Davis	"	.272	29.34	.471	N.	.025	....	.054	...	.143	.197	.248	.278	....	.240
37	Pondn. Pine.	" " "	"	.230	24.83	.398	N.	.051	....	.103	....	.259	.268	.324	.355	....	.324
38	Colorado Pine.	" " "	Ht.	.196	21.22	.340	.057	.017	....	.070	....	.196	.222	.299	.309	....	[illegible]
39	White Pine.	" " "	Ht.	.217	23.42	.374	N.	.063	....	.103	....	.178	.241	.281	.327	....	.281
40	" Spruce.	" " "	Ht.	.231	24.92	.400	N.	.045	....	.077	....	.163	.195	.268	.293	....	.268
41	White Pine	Gr. Northn. Ry.		.243	26.21	.420	.043	.027	.035	.059	.085	.125	.177	.213	...	...	.263

FIG. 48. ABSORBENT PROPERTIES OF TIMBER. (B)

ABSORBENT PROPERTIES OF TIMBERS.-WEIGHT &c. (C)

Series No.	Kind of Timber	Where from.	Heart or Sap.	Weight. Per cu. in. grs	Weight. Per Cu. ft. lbs	Spec. Grav.	Moistn. at Com. % Vol.	Absorption in Vol. 3 Hours	6 hours	24 hours	72 hours	7 Days	14 days.	30 days.	60 days.	Over 60 ds	Total at 30 ds *
42.	Norway Pine.	[illegible]	Both.	.237	25.60	.410	.005	.043	.053	.090	.115	.155	.222	.241	----	----	.242
43.	Tamarack.	" " "	"	.294	32.71	.577	.021	.023	.028	.044	.071	.117	.184	.233	----	----	.253
44.	White Cedar.	" " "	"	.200	21.63	.347	.012	.041	.049	.072	.098	.134	.192	.257	----	----	.269
45.	Arizona Pine.	Santa Fe' Pac.	"	.242	26.17	.426	.005	.041	.048	.072	.116	.149	.181	.199	----	----	.204
46.	Oregon P. (Fir)	" " "	"	.262	27.19	.434	.018	.018	.054	.084	.121	.154	.192	.212	----	----	.230
47.	White Mich. [illegible]	[illegible]	"	.248	26.79	.423	.013	.051	.060	.088	.117	.168	.236	----	----	----	----
48.	Tamarack.	G N Ry	"	.273	29.52	.474	.036	.067	.080	.114	.140	.186	.230	----	----	----	----
49.	Doug. Fir.	Santa Fe' Pac.	"	.249	26.92	.432	N.	.046	.054	.078	.115	.159	.210	----	----	----	----
50.	So. Yellow P.	Creo Resin.	Ht.	.428	46.18	.741	.027	----	----	.074	.102	.150	.209	.258	.304	9 a. d. .339	.285
51.	" " "	Treated. (S)	"	.648	65.28	1.122	.059	----	----	.077	.088	.099	.111	.134	.156	.170	.193
52.	" " "	Not "	"	.354	38.23	.613	.022	----	----	.073	.096	.134	.174	.230	.278	.300	.252
53.	" " "	Treated.	"	.580	72.68	1.006	.074	----	----	.101	.115	.131	.148	.175	.202	.224	.249
54.	Dead Pine (R)	Black Hills	Both	.292	31.53	.506	.059	----	.152	----	----	.278	.308	.369	----	----	.418
55.	" " (")	" "	"	.223	41.78	.387	.036	----	.095	----	----	.287	.373	.446	----	----	.482
56.	Live "	" "	"	.316	34.18	.548	.209	----	.061	----	----	.127	.145	.165	----	----	.374
57	Sweet Gum	Texas.	"														

Chicago Aug. 7th 1904 * This column for comparison. Saml. M. Rowe

FIG. 44—ABSORBENT PROPERTIES OF TIMBER. (C)

ABSORBENT PROPERTIES OF TIMBERS-WEIGHT &c. (Tp. in last page) (D.)																	*
Series No.	Kind of Timber	Wherefrom	Heart or Sap	Weight per cu" ozs	Weight per cu' lbs	Spec. Grav.	Moist at Com	Absorption in Vol. 3 HRS	6 HRS	24 HRS	72 HRS	7 Days	14 D's	30 D's	60 D's	Over 60 D's	Total at 30 D's
57	Sweet Gum	M.K.+T.Ry.Tex.	Bo.	.304	32.8	.527	.113			.104	.164	.202	.219	.254	.285		.367
58	Beech	Indiana	Ht.	.358	38.7	.621	.067			.081	.117	.143	.173	.214	.248		.281
59	Mt Pine (a)	New Mex.	Bo.	.260	28.0	.450	.021			.329	.381	.399	.422	.463	.503		.485
60	" " (b)	" "	"	.266	28.7	.461	.020			.321	.373	.402	.435	.469	.512		.489
63	Black Oak	Ills. Chanute	"	.384	41.4	.665	.149			.058	.080	.098	.122	.157	.199		.298
64	Red "	" "	"	.427	46.1	.738	.133			.070	.094	.123	.155	.196	.219		.329
65	Water "	" "	"	.435	46.9	.754	.198			.053	.068	.087	.126	.132	.151		.330
66	Cottonwood	Montana	Ht.	.228	24.6	.394	.049			.189	.295	.331	.359	.389	.426		.438
67	White Spr.	by J. O'Brien	"	.1926	20.8	.334	.023			.085	.125	.146	.186	.250	.265		.273
68	Tamarack	" "	"	.241	26.0	.4170	.035			.063	.110	.141	.195	.211	.225		.246
69	Bull Pine	" "	"	.2451	26.5	.4247	.055			.074	.106	.128	.167	.220	.247		.275
70	Tamarack	" "	"	.2931	31.65	.5079	.076			.050	.082	.130	.181	.233	.254		.309
71	Doug Fir	" "	"	.2910	31.43	.5043	.049			.051	.080	.115	.174	.229	.234		.278
72	" "	" "	"	.2712	29.29	.4700	.047			.066	.095	.119	.179	.226	.231		.273
73	Yellow Pine	New Mex.	"	.2394	25.86	.4148	.021			.110	.293	.317	.337	.380	.414		.401
74	White "	S. S. Hopper	"	.2505	27.05	.4341	.081			.069	.103	.123	.154	.195	.251		.276
75	Balsam Fir	"	"	.2354	25.42	.4077	.110			.099	.148	.168	.197	.227	.264		.337
76	Red Spruce	"	"	.3075	33.21	.5328	.026			.043	.066	.088	.123	.164	.197		.190
	Means.			.290	31.4	.503				.106	.155	.181	.217	.256	.285		
	Mean Ratio.									.372	.172	.091	.127	.102	.102		

Chicago Feb 10th 1902.

FIG. 45—ABSORBENT PROPERTIES OF TIMBER. (D) FOR "E" SEE PAGE 181.

ABSORPTIVE POWERS OF TIMBER.

A wide range of experience in treating timber for the purpose of preservation from decay, or at least for prolongation of its life by resistance of decay, has taught that the physical structure and condition of the timber is important in connection therewith.

It is in view of this that the investigations embodied in the tables (A) (B) and (C), are compiled. Much expense and labor has attended this work, prolonged as it has been through several consecutive years. Much valuable assistance has been rendered by various civil engineers and, as the work will be and is now being continued, further interest is invited for which due credit will be given. Without question, much can be learned in this way that is important to the operator of works now and to be engaged in the timber treating business, by a careful study of this matter. It will aid the judgment of the operator in adapting the process to the character of the timber coming to him and result in an economy of both time and expense.

EXPLANATION OF METHOD.

For the test of absorptive powers of the timber by immersion, the timber is procured cut to length as nearly as practicable, four inches, so as to present the best possible condition for the action of the capillaries. The blocks are first dried to nominal dryness, that is, to such degree of dryness that the wood will absorb or give off the moisture of the atmosphere successively as the air changes. When this is not practicable, the specimen is dried to this condition after it has gone through the immersion and the moisture at the initial time is determined and added to the absorption as shown as the total at thirty days. The thirty-day column is the quantities for comparison. The samples are weighed, the initial weight being noted, then immersed in pure Lake Michigan water and securely weighted down and there kept continuously except during the brief time used in weighing

at intermediate times until the thirty days have expired. The volume of the block is determined by measurements and by the further check of weight in water at the close of the test. The unit weight of water is taken for 65 to 70 deg. Fahr., being the uniform temperature of the laboratory, at .5771 oz. per cu. inch or 62.327 lbs. per cu. foot.

OBSERVATIONS.

It is not the purpose here in the limited condition of these investigations to go into an analysis of results in an extended way, and only such points as bring out the principles hinted at as are most noticeable as relates to their application to the treatment of timber.

Perhaps no way will better illustrate the effectiveness of the modern plant than a comparison of the results attained with these thirty-day tests with the ordinary one and a half or two hours exposure of the timber to the impregnating solution in the retort. In the one case a block four inches long, exposing all the natural sap ducts of the timber directly to the entrance of the water in the first case, whereas in the latter case the timber never less than eight feet long lacks this facility in a high degree, yet it absorbs more in that brief space of time, and an amount in volume at least 75 per cent of the total voids of the timber. In this connection it must be remembered that during the process of steaming that a considerable amount of the condensed steam remains in the timber after the vacuum is drawn and before the solution is introduced, and it is altogether probable that this with the solution absorbed, fully occupies every bit of the voids of the timber so that to put in more would be a physical impossibility. A comparison of these results at thirty days corresponds very nearly with the absorption obtained with the same timber at the various treating works now in operation, and it is believed to be of sufficient value to offer to those interested.

THE THREE-MOVEMENT PROCESS.

The Wellhouse process as taught and practiced in 1885 consisted of two applications, one of the chloride of zinc (one and one-half per cent strong) with the gelatine (one-half per cent) incorporated with the chloride. This was applied to the timber in the retort under 100 pounds hydraulic pressure for two and a half hours. Following the chloride, the tannin solution (one-half of one per cent strong) was applied under like pressure and conditions. No provisions were made to increase the temperature of these solutions above what was acquired by contact with the hot timber in the retort.

Under these conditions, with a one and one-half per cent solution, the Rocky Mountain pine absorbed from one-quarter to one-half pound of pure chloride per cubic foot, the former for sawed heart pine and the latter for hewn pole ties. This practice was introduced by Wellhouse and Mr. Joseph P. Card, M. Am. Soc. C. E., at that time associated with Mr. Wellhouse, at the time that the Las Vegas Timber Preserving Works were installed, and has been followed, with slight exception, in all the work at those works. The results are perhaps as well determined and definite as in case of any known process and practice and perhaps the most satisfactory in results of any except the more expensive process by creosote oil.

To distinguish this practice from others consisting mainly of a modification of this, we will call this the "two-movement" process.

There are several modifications suggested by subsequent experience, among which are:

1st. Application of the gelatine in a separate solution, thus requiring another movement, hence the designation "three-movement."

2d. The application of much higher temperature to the various solutions.

3d. The increase of the strength of the chloride solution used to the end that a greater quantity of the chemical be injected.

Practically, these three points cover those of greatest moment at this time, and we will take them up in the order given.

The grounds upon which the three-movement practice is advocated is that with the gelatine added to the chloride solution, the former being of a viscous nature, retards the ingress of the chloride and renders it difficult to get enough into the timber.

It is true of the gelatine that it is impossible to reduce it to such consistency as that it will penetrate the solid parts of the wood. It can never be reduced to a true solution so that it will be carried into the wood by the water in which it is dissolved, and the greatest possible penetration is where it follows the more or less open ducts of the wood, or cracks and checks that result in or during the drying of the timber. The addition of chemicals to cut or render the gelatine as fluid as possible, or the application of a high degree of temperature, are the agents that will induce the greatest penetration. If the gelatine is used in simple solution, the heat is the agent most effective, and without the heat the glue will spread on the surface of the timber like a coat of grease or paint, and very slightly penetrating the pores or checks of the timber. It is equally true that when the gelatine is incorporated with the chloride, that the latter helps to hold in solution. It also follows, that the large volume of the chloride solution absorbed (about ten times that of either that of the gelatine or tannin when applied alone), that the glue would be more thoroughly introduced in the surface of the timber than is possible if applied separately.

It is claimed to be possible, too, that if introduced incorporated with the chloride, that a portion of the gelatine will penetrate beyond where it will be reached by the tannic acid, and therefore it will be left in the wood as a seed for decay on account of its extreme perishable nature. When the tannic acid is pure it is as thin as water and is a solvent in the true sense, and will penetrate as far as the water goes. Then if we cipher a little, using every day experience as to

the amount of the tannin solution that must enter the timber under the 100 pounds pressure, we find that the timber must be penetrated nearly one inch over its whole surface; more where pores and checks offer free access and less where solid and compact wood prevents.

The fact that the high results were attained under the process as initiated by Mr. Wellhouse himself, and the further fact that by proper means applied, almost any desired quantity of the chloride can be injected under the two-movement process, and in less time for the whole treatment of a charge of timber, would seem to be a sufficient answer.

NOTE.—Since the foregoing notes were written the writer has had some experiences with timbers of the Pacific slope. The fir and the tamarack, especially the latter, is impregnated with difficulty, the volume of absorption being meager as compared to the western and southern pines, hence if high amount of chloride is desired, unusual means must be resorted to. While it has not yet been satisfactorily proven that the glue does reduce the amount of absorption of the chloride, yet in view of this possibility, the separate application of the glue may be justifiable. With these exceptions there is not sufficient reason to prolong the process for the separate application of the glue.

A careful test at Greenville, Tex., showed no appreciable retardation of the absorption of the chloride by the presence of the glue in the chloride solution. This is true wherever the open grained timber is treated, notably the pines of Texas, Colorado and New and Old Mexico.

INCREASE OF STRENGTH OF SOLUTION.

We have seen that heart timber with one-quarter pound of the chloride per cubic foot of timber when in the shape of a 6 in. x 8 in. sawed tie, resulted in a measurably sound tie after it had become useless from rail wear. We may therefore conclude that a less amount would have served equally well. Then we find that the pole tie, mostly sap, having one-third of a pound, has its usefulness prolonged from two to three times the life of an untreated tie of the same character.

Then why increase the cost of the chloride fifty per cent simply to make sure to get in enough?

Let us examine the philosophy of the process. It consists of three essential parts or effects. First, the steaming, then the impregnation and lastly the plugging up of the outer part of the timber by which the antiseptic introduced is protected from waste. The first frees the timber from those juices that cause the inception of decay and which feed it after it has commenced, the second introduces the antiseptic properties which, while present in the timber, effectually prevent decay, and the third aids in retaining and preventing waste of the preserving properties.

Not all, by any means, depends upon the antiseptic. The steaming must be prolonged sufficiently to allow the heat to reach the center of the piece, but if this is not done, there will be a section at the center of the tie in which the objectionable juices of the timber will remain and which the antiseptic, when introduced, both by the steam and by the antiseptic must be had, otherwise the work is imperfectly done. The permeation by the steam is the paramount result to be secured and even should the amount of the antiseptic be reduced by oversteaming, yet, its permeation is more complete and a little less well distributed, is better than much more confined to the outer portions of the piece. While a stronger solution may put in

the desired pounds, yet such practice cannot be characterized except as waste.

Fifty per cent increase in the amount of chloride can be figured and amounts to a sum that it is not cared to name, and if it is unnecessary, would not be justified by anything but "speculative reasons," which would hardly pass with business men.

GREATER AMOUNT OF HEAT.

As before stated, little attention was paid to the temperature of the two solutions then used. Later investigations by experienced observers have strongly impressed the conviction that heat is a very active element, not only in its application to the charge in the shape of steam by which the saps of the wood are dissolved and expelled and the timber prepared for the free ingress of the solutions, but in the shape of increased temperature to the various solutions as creating more favorable conditions for the desired and necessary chemical actions. In using the two-movement process the heating of the chloride solution is important from the fact that with it is carried the gelatine to which high degree of temperature is necessary for best results. Where the gelatine solution is used simple, high temperature is *absolutely necessary*. With the two-movement process the temperature of the chloride solution keeps measurably high from the heat derived from the steamed timber, hence less heating appliances are necessary. The tannin solution requires some heat to promote its chemical combination with the gelatine though not so great a degree but its temperature should be controlled as well as that of the others.

The improved heating coil for the solution tank shown on page 25 and the retort coil, page 118, enables the operator to fully control the temperature so that 150° to 180° F. can be secured, and the retort coil will bring the creosote oil to the boiling point, at 190° to 200° F.

DOES CHEMICAL TREATMENT OF TIES INCREASE THE HARDNESS OF THE WOOD AND THE HOLDING POWER OF THE SPIKE?

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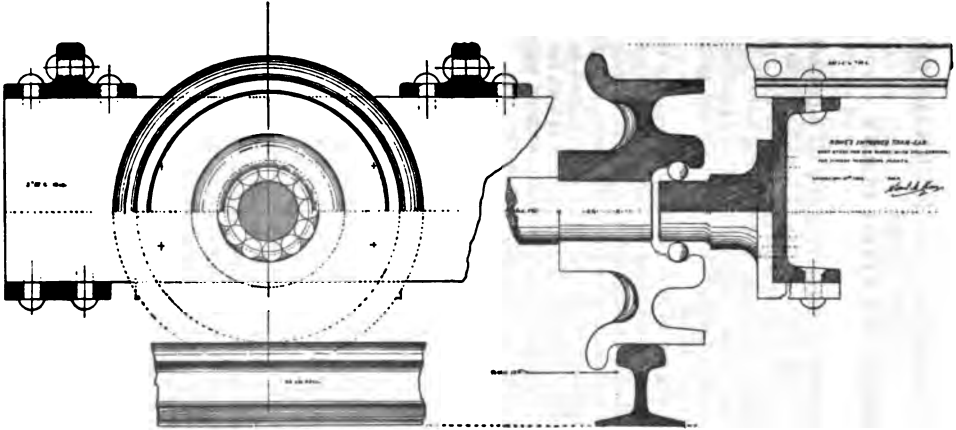
Report of a committee presented before the 19th annual convention of the Roadmasters' and Maintenance of Way Association, Washington, D. C., Oct. 8-10, 1901.

This paper refers only to the zinc-tannin or Wellhouse process of timber preservation, and the committee to whom the subject has been assigned, has made several tests with the treated ties available, and has received the written opinions of persons in different parts of the country who have had experience in the treatment and use of treated timber.

The consensus of opinion, supported by the tests made by your committee, is that treatment does not increase the hardness of the wood, but does increase its density and transverse crushing strength in proportion to the amount of treating material absorbed. But, while the timber is not hardened by the treatment, it is made more flexible and tough, and will, by reason of the increased density of the wood and action of the chemicals used, prevent the rail from cutting into the ties, in proportion to the amount of preservative absorbed, or about 30 per cent in coarse grained pine.

Common mountain pine, such as is found in New Mexico and Arizona, now largely used as tie timber on western lines, is an open grained, coarse wood, and absorbs, when treated, about 30 per cent of the preservative. Close grained, firm timber absorbs less of the chemicals than does the open grained soft wood, and is, therefore, proportionately less affected by the treatment.

We find that the spikes, when driven, damage the fiber of the timber less in treated than in untreated timber. The holding power of the spike is not noticeably increased at the time the tie is treated, but increases as the timber dries out, until at the end of from six to nine months, when the timber has become seasoned, a pine tie which has absorbed the usual amount of chloride of zinc, tannin and glue, will have increased the holding power of the track spikes not less than 30 per cent.



ROLLING BEARING FOR TRAM CAR AXLE.
For Timber Preserving Plant.

This wheel and box are intended for a car with 35¾ inches between channels. The balls are introduced before attaching box to channel beam, the balls being held in place by filling the travel way in the wheel with a little tallow while the spindle is introduced. For other sizes and make of car, the length of axle can be varied.

ROLLING BEARING FOR JOURNALS OF TRAM CARS.
TIMBER TREATING PLANT.

The impossibility of preserving any oil lubricant in consequence of the high degree of heat to which the cars are exposed during steaming, suggests the application of the rolling bearing. The drawing here delineated is one of perhaps many plans for its application. It has the element of simplicity which should prevail throughout the whole car.

With what degree of success it will cover the difficulty can only be determined by trial, both as to ease of draught and of standing the wear. The wheels on these cars are necessarily of small diameter, as it is of the first importance that the area of the load be as near as possible to the full area of the retort, hence a reduction of two inches can be made without appreciably increasing the draught, then a corresponding gain is made in increase of the possible loading.

The cars as now made for the 72 inch (dia.) retort, have wheels ten inches in diameter and two and a quarter inch axle with the ordinary provisions for oiling, which are only available after the charge is drawn. The fact is that if the diameters of the wheels were considerably reduced, they would sled and not turn at all, and the whole load would be sledded out.

When, as heretofore, a powerful wince is used, this heavy draught has not been so appreciable, but now that other and perhaps better kinds of power are being sought, it becomes necessary to meet it.

Electricity and compressed air now vie for a place or means of power with probability in favor of the latter eventually, both for the yard wince and the locomotor for distant yard service. The steam locomotive being ruled out by danger of sparks in a large collection of material in the yard. and also for operating the wince owing to the difficulty of conveying steam so far. Electricity is well adapted to both the wince and the yard locomotor. Equally well can the compressed air be applied to each of these purposes

While the latter is more prompt in responding and better in consequence for moving the charge to or from the retort than the electric motor, the two in common have their limitation in the amount of traction they can command. For charging or discharging, the wince is transcendently the best adapted, as this should be done with the greatest care or otherwise serious damage may result to the retort and attachments. The charge including the tram cars will weigh more than the empty retort, hence if the engineer of the motor is obliged to make a run to get his charge in, serious damage is almost sure to result first or last. With the wince a stop within a few inches is practicable. It is claimed by the manufacturer of the air motor that their locomotors are equally under control. As regards the electric motor it is not. In any case, a remedy for the heavy draught of the tram train is being called for and must be provided.

The relative merits and cost of installation of these two means of power are as yet unsettled but probably will be settled in the near future, as each has its advocates; and really the best method, and about the only one, will be that of results after trying. It appears, however, at this time that the compressed air is both the best adapted and the cheapest to install and to operate.

The compressed air motor seems the best in the respect that its installment can all be placed in the ground, its feeding points so located as to always be in easy reach when the motor needs to recharge, and the motor is free to go quickly to any part of the yard as needed, whereas the electric motor can only operate where the tracks are wired. For the wince, the electric power is an ideal one as is also the compressed air. One difficulty in using the compressed air is that the high power necessary to operate the locomotor is unsuited to operate the wince, or so at least was apprehended, but later this has been overcome by using the compressor that is used to move the solutions.

The C., B. & Q. R. R., at their works at Sheridan, Wyoming, are now doing this quite successfully, thus

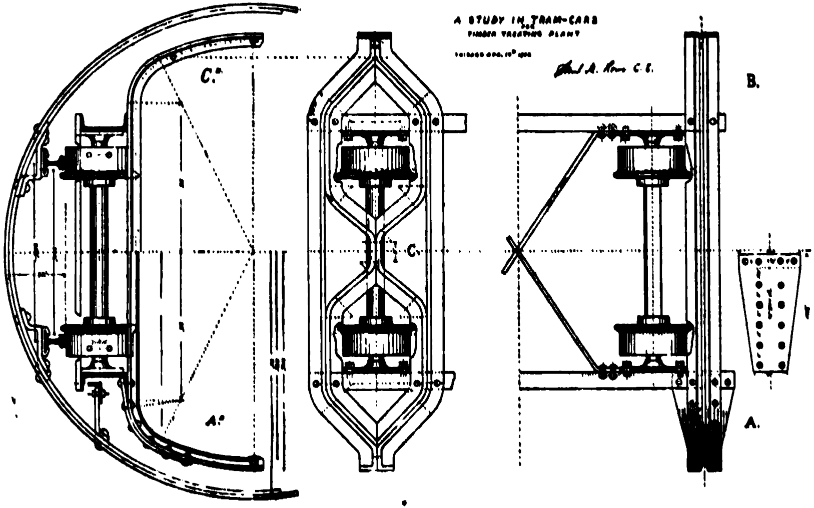


FIG. 55.—A STUDY IN TRAM CARS.

doing away with the necessity of a special engine for the lower pressure.

THE PROPER PROPORTION FOR THE RETORT.

In the first place the diameter of the retort should be such as to receive the car of the most convenient dimensions for loading and unloading. The most common diameter is that of even six feet which receives a car the load of which will be near six feet from ground level, which is about as high as men can load economically. The cars best adapted to this service must be as light as practicable and strong, above all, strong, and as simple in construction as possible. In proportioning the car all these requisites must balance as nearly as possible.

Any effort to strengthen by increase of weight is likely to defeat its purpose, as in use these cars receive much harsh handling that is made still more destructive from the added weight.

The door for sealing the retort would have to be stronger in all its parts if the diameter is enlarged, and the door, if self sealing, is quite an important part of the cost, and when adapted to one dimension, and that the most suitable, any change is to be deprecated.

Much has been said in favor of the bolted door, but a little observation must satisfy the observer of the superiority of the "Spider Door," both for economy of time and labor.

A retort of this diameter is amply strong to stand the service, both for the necessary pressure and for its stability in form.

The length can be made to suit the conditions or fancy, but should not exceed 120 feet and may be anything down to 40 feet.

SHOULD TRAM CARS HAVE COUPLING?

While recognizing the necessity of keeping up with the times, the fact that the tram cars have heretofore been handled without difficulty without the coupling appliances, there seems to prevail an impression abroad that the omission of these appliances is a grave one. Why?

The only seeming result where couplings have been provided, is that their use is neglected and a lot of surplus chains are around in the way. The fact that the cars with loads or without can be pushed ahead with any power, or can be drawn by means of a suitable cable, even to the charging and discharging of the retort, seems to point to lack of any necessity for them.

The provision of light cables of about the length of the retort, any train of loads or of empties can be hauled safely by the motor over any part of the yard. The same is true with any lesser number of cars.

Perhaps ninety-nine per cent of the labor in connection with the plant is in handling the material, including the handling of the tram cars in placing them; dangerous enough in itself to hands and limbs and the additional risk in coupling should not be incurred without better reasons than now appear. The extra expense of the couplings cannot be neglected as it is considerable, saying nothing of the time required in coupling a loaded train, which at best is a troublesome and a dangerous operation. "A word to the wise, etc."

THE TIE LOADER.

INTRODUCING A LABOR SAVING APPLIANCE.

The most severe labor connected with the operation of a timber preserving plant is the unloading of the treated ties into box cars.

For economic reasons a large part of the output is thus delivered, and the fact being that these freshly treated ties have from fifty to seventy-five per cent of

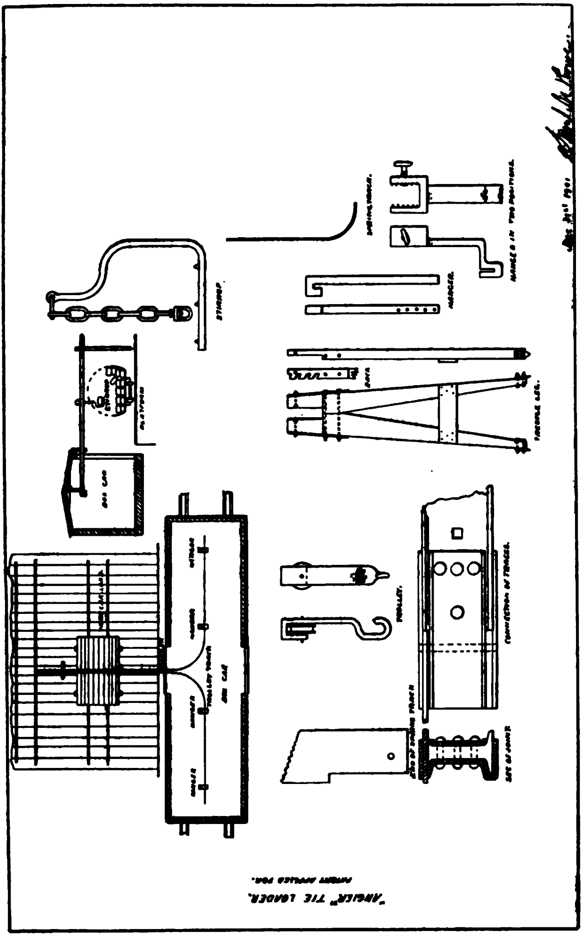


FIG. 57—ANGIER TIE LOADER.

weight added to the normal weight, renders them very heavy, requiring from two to three men to lift and carry them into the car. For two men the labor is so severe that it requires an athlete to stand the labor, and it is very difficult to secure men to do this part of the work. Much delay always results from this difficulty when organizing a force.

The illustration given on the preceding page shows "The Angier Tie Loader" (patent pending), which is now ready to offer to those desiring such an aid. It is claimed that two men will load more ties into a box car than four men can do by hand, and that the labor is brought within the strength of any ordinary workingman.

TABLES FOR CONVENIENCE IN COMPUTATIONS.

FOR LABORATORY WORK.

Measures. Cubic feet, (1728 cu. in.). Cubic centimeters, (eq. .0610254 pr. in.).

Weights. (Avoirdupois) lbs. ozs. fractions of oz. to 4 dec. and grains. (7000 grs. to 1 lb. av.) Using ozs. as units generally.

For temperature. Fahrenheit thermometer.

For liquid density. Beaume hydrometer (in gross .0 to 60 deg., and for fine .0 to 5.00 deg., Be.).

Table of Ounces and Grains in Fractions of an Ounce.

1 grain	equals	.0023	ozs.	10 grains	equal	.0230	ozs.
2 grains	equal	.0046	"	15 "	"	.0343	"
3 "	"	.0068	"	20 "	"	.0457	"
4 "	"	.0091	"	25 "	"	.0571	"
5 "	"	.0110	"	30 "	"	.0686	"
6 "	"	.0137	"	35 "	"	.0800	"
7 "	"	.0160	"	40 "	"	.0914	"
8 "	"	.0183	"	45 "	"	.1028	"
9 "	"	.0206	"	50 "	"	.1143	"

One oz. av. equals 437 grains. One-half oz. equals 218.75 grains. One-quarter oz. equals 109.4 grains, and one-eighth oz. equals 54.7 grains.

DRAWING A VACUUM.

Computations by Prof. S. W. Robinson, Professor of Mechanical Engineering, Ohio State University, Columbus, Ohio, Nov. 24, 1900:

Answering your letter, I found it to take quite a little study. I assume that your pump has a clearance to be filled at each return stroke as if the piston had a hollow spot, or that a valve required a space, or something, so that at end of return stroke there was this clearance vol. that cannot be rid of; represented by the vol. e. f. on sketch. This is always constant.

These values 4", 3.55, 3.12 and 2.78 are the limit to which your pump lowers the barometer column to, at limit of exhaustion by pump, and are proportioned to the barometric columns at the stations before pumping. That is, the above figures are proportional to 30", 26.62" 23.38" &c., in a given air pump, whatever the air pressure.

It may be the air pressure to lift the weight of valve &c.

Fine physical laboratory air pumps require this valve to be lifted by force automatically.

Now as the piston of your pump lifts, assume first, that the air under it remains constant temp., and that the vacuum is about completed as far as your pump will do it, then, at any stroke or two, the pressure will be, say 30" mercury at sea level where, for now, assume the pump to be. On lifting piston from C. to B., the stroke (O. C. being clearance), the falling pressure with increasing stroke will, for air at constant temperature in pump, describe the curve D., F., G., L., &c., stopping at L., actually, as end of stroke; but if piston kept on, the line would continue as to x.

At 3,500 feet elevation, the curve would be at H. M. At 7,000 feet elevation the curve would be at I., N., or at top of Pike's Peak at 14,500 feet elevation the curve would be at J., O, and so on.

In your letter you speak of the terminal mercury column being 4" shorter or 26" instead of at air pressure, 30"; or really, I suppose the column connected

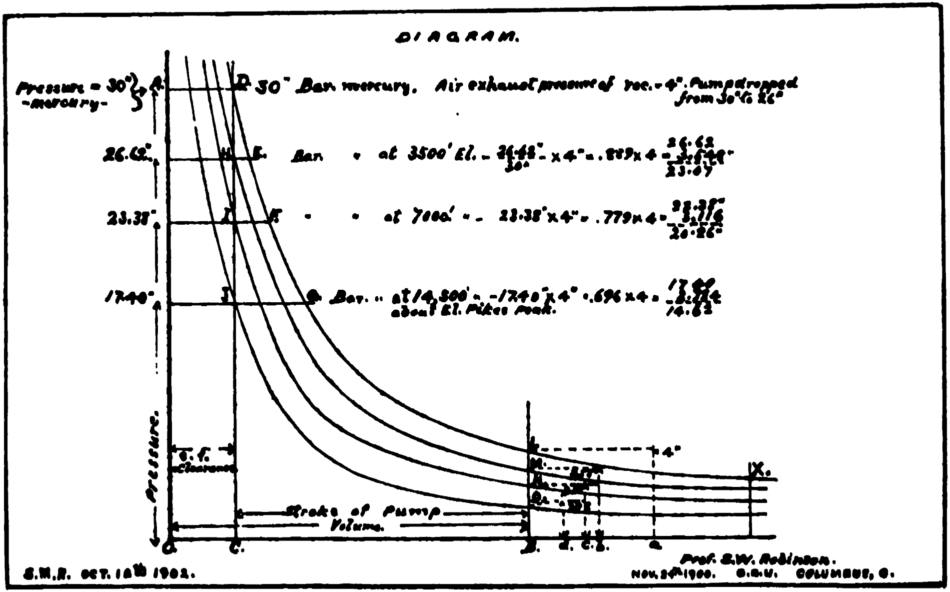


FIG. 59—DIAGRAM VACUUM.

with the clearance side of pump will stand at 4″ when the pump has reached its limit. This 4″ will be found at L., on the curve when the pump has completed its stroke, or a stroke at finish of pump's practical vacuum.

Now these curves will be equilateral hyperbolas of air expansion, where equivalent of curve is xy=constant, or say eq. AD×CD=xy. Consequently the values BL, BM, BN, etc., will be proportional to CD, CH, CI, etc., respectively, so that when the barometric heights are 30″, 26.62, 23.38, etc., the heights BL, BM, BN, etc., become known. (For sudden or quick pumping, the curve is adiabatic.)

The values, 26.62, 23.38, etc., are to be determined by some barometric formula from the heights such as you gave as 3,500 feet and 7,000 feet elevation. This formula is the well-known Laplace barometric formula you may be familiar with, which is:

$$\text{X. (ft. in el.)} = 60346\,(1.+.00256 \text{ Cos. } 2\phi)\left(1+\frac{2T+T_1}{1000}\right. \times \log \left.\frac{H}{H_1}\right)$$

T and T_1 are centigrade temperatures at two stations, and H, H_1, bar. hts., I drop out the (ϕ.) whole parenthesis or latitude term in my calculation here, giving:

$$\text{X. in feet,} = 60346.\left(1+\frac{2T+T_1}{1000}\right)\left(\log \frac{H}{H_1}\right)$$

With this data I now arrive at a set of figures thus:

At	200	ft.	el.	30	in. mercury	tem.	60	deg.	Fah.	—16	deg.	C.
"	3,500	"	"	26.62	"	"	50	"	"	—10	"	"
"	7,000	"	"	23.38	"	"	40	"	"	— 4.4	"	"
"	14,500	"	"	17.40	"	"	32	"	"	— 0.0	"	"

Now allowing for the residual mercurial columns, measuring your vacuum, at the different altitudes of 4″, 3.35″, 3.12″ and 2.78″, etc., you get

$$\left.\begin{array}{l} 30''—4''=26'' \\ 26.60—3.35=23.07'' \\ 23.38—3.12=20.26'' \\ 17.40—2.78=14.62'' \end{array}\right\}$$ As indicating the mercurial column which represent your vacuums.

These figures in last column are really exactly the same as you have given in your letter for the highest viz. 26" at sea level, 23" at 3,500 feet elevation and 20" at 7,000 feet elevation. You say 24" to 26", 23" to 21", 18" to 20", as if you readily got the lower values at each place, and that the larger values at each place were the limits. These exactly agree with my results. I used your 4" as from 30" to 26", 4" at lower station. This treated by the diagram gives the other figures.

To go farther with the columns toward the perfect vacuums will require a more perfect pump or one with less clearance. One way with same pump is to have oil or water to stay in pump to fill clearance e. f. at each return of stroke.

PROF. S. W. ROBINSON,

Nov. 24, 1900. O. S. U., Columbus, O.

THE DETERMINATION OF LIFE OF TREATED TIMBER, IN RAILROAD TIES.

The determination of life of timber when exposed as in cross ties or sleepers in a railroad track with any degree of precision is, for several reasons, very difficult. To approach anything near it requires a careful record in detail, which is very difficult to keep for a sufficient length of time as things go. Even if this was done ever so carefully and definite data were secured in one locality, the differences in climate, soils and conditions would give something quite different at another location.

This being the conditions, we will have to be satisfied with an approximation.

The following sketch is intended to show some deductions from the limited records in reach as furnished by the A. T. & S. F. Ry. on the treated mountain pine ties. The percentages as shown by line A. as regards the first eight years, is derived partially from the early periods of subsequent years (after 1896), where number of rotten ties removed have been reported. From 1897 to 1900 we have full record.

Wellhouse Process—A.T.&S.F.Ry.				(6 years) (6.)		7	8.	RATE OF RENEWALS % + Years in which removed mostly							"S"	"P"			
Date Treated	No. Treated	Rep. Rem 1897-1900	Should have been removed	Date removed 1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	Should be Renewed	In yet	No. yrs. in track	Percent remaining	Rem
1885	111,503	41.219	32576	780	2230	6690	8586	9478	10270	10816	10816	10035	8920	7805	86 286	25247	15 yrs.	22.6	1335 miles track
				5.	6	7	8	9	10	11	13.112	18796	11 984	7.770	(54.461)				"S" 3.525 000 Ties
1886	333,298	52,212	121321		333	6666	19998	25664	28330	30.997	32330	32330	29.997	26649	233309	100.099	14 "	33.3	"P" = 2.577 617 = 73%
					5	6	7	8	9	10	24706	18160	12976	6.876	(62706)				
1887	159,286	72.664	72.998			1325	3788	11363	14583	16078	17613	19170	19170	17045	120155	69231	13 "	36.5	"S" = 771.186 ÷
						5	6	7	8	9	22880	25908	22647	16 900	(88305)				3 yrs.
1888	285.104	55.776	106.059				1996	5702	17106	21953	24234	26515	27655	27655	151816	131288	12 "	46.4	257 062 Ties per
							5	6	7	8	14350	19274	20479	13092	(67.195)				annum = 7.3%
1889	169.174	19432	59.549					1884	3384	10.150	12026	14380	15733	16410	74967	94207	11 "	55.6	= an. 13.7 yrs.
				1.	2.	3.	4.	5.	6	7	3287	5942	8934	6227	(23 390)			(t)	(379 054) renewed
1890	35.600	16,970	11.224						240	712	2136	2752	3026	3310	12.176	23424	10 "	65.8	in 4 years 1897-1900
									5.	6	3306	3810	8240	6077	(21442)				= 94763 Ties per an.
1890 B.	7,153	1,346	2.253					4.	50	143	429	551	608	665	2.446	4.707		65.6	(P) = 496.730, by rule
											708	216	568	216	(1 708)				removed in 1897-1900
1891 B.	128 568	10,343	31.113						4	900	2571	7714	9900	10918	32013	96555	9 "	75.1	incl. against (t) =
											1820	1909	5862	3702	(12.993)				(379.054) = 76.3%
1892	137,771	20,907	22.593							4.	964	2755	8266	10608	22593	115178	8 "	83.6	496.730
											329	5025	12077	7860	(25.791)				of what renewals
1892 B	49,499	1,351	7771							4.	347	989	2970	3465	7771	41.728	8 "	84.3	Should have been
											192	297	900	1416	(2754)				(t) = Ties removed in
1893	178,167	9.523	15856					1	2	2.	256	1247	3563	10690	15856	162 311	7 "	91.1	3 years 1897-1900.
											499	3475	4851	5622	(14392)				= 103.351 per year.
1894	247.666	2.289	8417						1	2	3	4.	3466	4951	8417	239149	6 "	96.6	TOTAL TIES IN TWO
				Note.							208	228	1452	1132	(3020)				DIVISIONS 3.252 000
1895	256,677	565		This table is based upon an assumed life of						1	2	3.	513	1898	2411	254466	5 "	99.0	÷ 293.755 PER AN.
				twelve years. The record of three years, middle of							51	132	349	165	(697)				TAKING LIFE AT 12.3.
1896	336,070	324		1897 to 1900 indicates that only 50% of the number							1.	2.	3.	4.		336070	4 "	100.0	B. Ties Renewed
				of ties that should have failed, have been removed,															41,182 in all, or 1%.
1897	380,523	60		showing that the probable life is nearer 14 years.								1.	2.	3		380523	3 "	100.0	
1898	350.237	384		See (t) at foot of col. (S).									1						
1899	460,382													1		350337	2 "	100.0	needs for 4 years.
1900	151,997			Chicago, Oct 30th 1900 — [signature]							(91.562)	(100271)	(121.218)	(76.053)	(t) (379.054)	151.997	1 "	100.0	(97276)
Total	8720.498	310,086	496.720	(P)						By rule	109522	119.798	133.787	142094	771186	2,577,517	S...	73.125	124876.

FIG. 62—RATE OF RENEWALS, (WELLHOUSE PROCESS, A. T. & S. F. RY.).

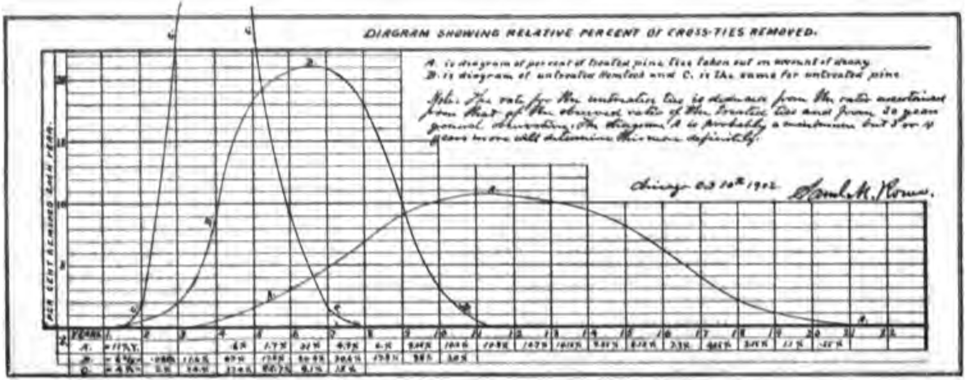


FIG. 58—DIAGRAM SHOWING RELATIVE PER CENT CROSS-TIES REMOVED.

It will be seen here that the mean life is near eleven and one-half years, and that the rate so far as to life is the minimum. We do not know how many ties of each year's treating have been removed previous to the commencement of the record in 1897. Referring to table compiled in October, 1900, compiled on the presumption of twelve years mean life, we find that not nearly so many rotten ties are being removed as should have been. (Only from 50 to 75 per cent.) Should the same be true as to the years from 1885 to 1896, then it is presumed that our line is too high at first and that in the end a year or two more can be added to the mean life here shown for treated ties.

Awaiting the time when the record shall have been completed, we shall have to rest content on what we have.

The line B. B. is intended as an approximate for untreated hemlock and C. C. that for mountain untreated pine ties, presuming that much the same law will govern as with the treated ties.

Granting that the diagram is anything near right, it speaks "graphically" for itself.

ON THE ECONOMIES OF TIMBER PRESERVATION.

(Copy)

ON LINE, Sept. 14, 1902.

MR. H. U. MUDGE,
General manager, A. T. & S. F. Ry.,
Topeka, Kan.

Dear Sir:—I beg to acknowledge receipt of your favor of September 8, which was forwarded to me while on the line west, giving figures showing the average life of treated ties taken out of track during the year 1901. It would seem from the statement that the best results you receive from your Rio Grande division, next coming the New Mexico division. From the divisions east of the Western division, it would seem there was not much economy in the use of the treated tie, the average life being

practically eight years. Of course, this is considerably over the life of the tie untreated, still at the same time the additional cost of the treated over the ordinary pine without treatment would, in my mind, make up the difference. I should be very glad indeed to hear from you on this subject, and whether you consider the tie economical to use east of our Western division. Yours truly,

(Signed) RUSSELL HARDING,
3d Vice-Pres. and Gen'l. Mgr. Mo. Pac. Ry.

(Copy)

TOPEKA, KAN., Sept. 26, 1902.

Tie Treating Report.

MR. RUSSELL HARDING,
3d Vice-Pres. and Gen'l. Mgr. Mo. Pac. Ry.,
St. Louis, Mo.

Dear Sir:—I am in receipt of yours of the 14th inst., hereon, and note contents. It would probably have been better when these reports were sent out if special attention had been called to the fact that the figures represented only the average life of treated ties taken out on account of rot during 1901, and not the average life of all the ties treated during each year.

We commenced wood preservation in 1885 at our Las Vegas plant, treating only mountain pine and laying the ties west of Dodge City, Kansas, but principally in New Mexico. Unfortunately, it was not until 1897 that we realized the necessity of keeping record of the service obtained through this work, so that from 1885 to 1896 inclusive, while we put in 2,528,746 treated ties, we have no record of how many were taken out each year or the reason, consequently cannot give any present average life of service, for those still in, and must, until our present records are old enough, be content with knowing the average life of those taken out.

In 1898 we commenced getting treated Southern pine ties from the Texas plant at Somerville, but these have not yet been in long enough to give us re-

liable data from which to determine the percentage of saving, although the Southern Pacific, who have been treating loblolly sap wood since 1886, using the same system of treating that we have, that we now use, claim that it about doubles the life of the tie at less than one-third its cost. This is practically our own experience, even judging by the ties which have come out of the Western end where we have had long enough time to base an opinion upon. You will see by the record sent that in 1901 we took out 4,472 mountain pine ties which have been in the track since 1885—sixteen years' service, when at the most without treating we could not have expected more than six years, and I am satisfied there are quite a few thousand ties of 1885 yet in the track and good for two or three years more service.

Answering your remarks as to the economy of treated ties east of our Western division, in considering this it would not be fair to include the number taken out from "other causes," which cover those broken in accidents or removed for reasons entirely outside of the question of treatment; but when the number removed on account of rot is considered alongside of the total number put in, it will be seen that it bears a very small proportion to the number inserted in track, as you will see by figures given:

In connection with these figures, and with our averages as a whole, it must not be overlooked that it is the "weak sisters" which come out first; the strong, sound ones remaining in a much longer time under the principle of the survival of the fittest.

I certainly consider that our experience and economy also warrants us in the use of treated ties on the whole of our road, and believe good results will be apparent in course of time from those put in on the Eastern end, as well as on the Western. This year we had to put in a good many ties not treated, but it is because we are unable to get all of the other kind that we called for.

STATEMENT.

Treated Pine Ties.

Eastern end, east of Western and Colorado Divisions.

Taken out between March 1, 1897 and December 31, 1901.
Entered against year in which they were treated.

Year in which treated and put in track.		Ties in Track Jan. 1, 1902.	Rotten.	Other Causes.	Total
1897	27,831	27,818	11*	2	13
1898	314,126	314,066	37†	23	60
1899	658,775	658,664	....	111	111
1900	787,377	786,789	5	583	588
1901	658,694	658,676	....	18	18
Total	2,446,803	2,446,013	53	737	790

Western end.

1897	242,750	242,309	305*	136	441
1898	334,058	333,727	101†	230	331
1899	351,570	351,359	21	190	211
1900	375,132	375,121	....	11	11
1901	402,540	402,483	2	55	57
Total	1,706,050	1,704,999	429	622	1,051

Total on A. T. and S. F. proper.

1897	270,581	270,127	316*	138	454
1898	648,184	647,793	138†	253	391
1899	1,010,345	1,010,028	21	301	322
1900	1,162,509	1,161,910	5	594	599
1901	1,061,234	1,061,159	2	73	75
Total	4,152,853	4,151,017	482	1,359	1,841

*Mean for 4 years rotten .00094
†Mean for 3 years rotten .00021 - - - Rowe.

We expect to have more and special attention given to this wood preservation matter in the future, and through our own experiments in a small plant put up here for that purpose, and are in hopes of so improving our treatment as to get even better results than in the past. (Sig.) H. U. MUDGE,
General Manager,
A. T. & S. F. Ry.

COST OF TREATING TIES.

The appended table gives the average cost of treating ties at the several plants. This is the net cost covering chemicals, labor, fuel and supplies only.

The character of the timber varies so that the strength of the chloride of zinc solution also varies from over four per cent in some cases to one and one-quarter per cent.

TABLE.

Process.	Cost of				
	Chemicals.	Labor.	Fuel.	Supplies.	Total.
A. Wellhouse........	$0.0680	$0.0343	$0.0058	$0.0026	$0.1107
B. "	.0842	.0469	.0043*	....	.1354
C. Burnett...........	.0616	.0709	.0037*	....	.1362
D. Wellhouse........	.0885	.0303	.0038	.0032	.1258
E. "	.0716	.0345	.0084	.0021	.1168
F. Burnett..........	.0554	.0329	.0086	.0015	.0984
G. Wellhouse........	.0677	.0706	.0301	.0055	.1739
H. Burnett...........	.0622	.0268	.0025*	....	.0915
I. "	.0369	.0279	.0083	.0033	.0764

*Supplies included.

mex. Cur.

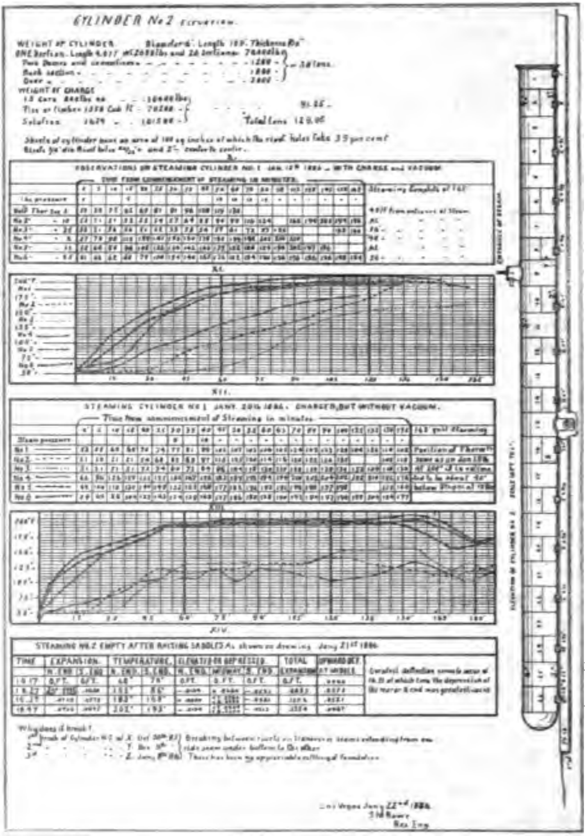
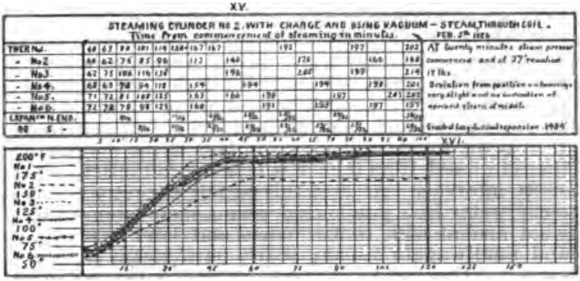


FIG. 24—RETORT NO. 2, SHOWING CAUSE OF BREAKAGE.

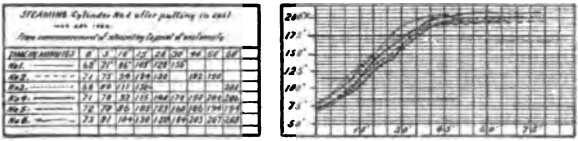
INTRODUCTION OF STEAM TO THE RETORT.

In 1885, when the Las Vegas plant was first installed, the steam was introduced through the upper dome near the middle of the retort. Great distortion of the shell of the retort was at once apparent and several breaks by tearing the steel sheets succeeded each other at short intervals. These failures were at the bottom of the retort near the middle and were quite expensive to repair, requiring large patches.

XV.



XVII.



It was evidently due to the sudden heating of the top of the retort before the steam reached the bottom, the top sheets being expanded so as to throw it into an arch, causing tension on the bottom sheets beyond what they would stand.

The whole difficulty was remedied by introducing the steam at the lower dome and carrying it to each end and there discharging it, thus filling the whole area of the retort with steam, the air being allowed to escape through the top dome as fast as the steam from each end displaced it.

The diagrams here given, with one given on page 57 of the hand-book, will sufficiently illustrate the causes of breakage as well as suggestive of the remedy to be applied.

MEASURING THE SAPS EXTRACTED DURING THE PROCESS OF STEAMING.

In seeking a method of determining the amount of saps or soluble matter extracted during the process of steaming, the only practical method would seem to be by observing the changes in weight of the wood, and taking careful note of the effects produced.

Assuming that the wood is dry when introduced, the steam is introduced and held under the required pressure until the wood is heated to the boiling point. In practice we find that much of the steam required to heat the wood condenses and falls to the bottom of the retort and from thence is blown into the sewer at short intervals. At first this outfall is pretty nearly clear water from condensed steam, then later somewhat loaded with timber juices and later heavily so and finally again bearing nearly pure steam condensation. Then the vacuum follows, drawing the vapors from the timber and from the retort. If at this stage the timber is withdrawn from the retort, if introduced dry, will have increased in weight, but if introduced green and sappy, will be lighter, but we cannot tell in either case how much steam has condensed in the timber during steaming and how much is drawn away during the vacuum. But if we weigh the timber before treated and then again after, we have the increased weight, and by the tub gauge we have the amount actually absorbed.

Invariably this latter quantity is much greater than the increase in the weight of the timber by treatment. Then the difference is evidently the amount of sap or soluble matter drawn from the timber. In no other way can this be determined during the ordinary process of treating timber.

RULE.—Subtract increase of weight of timber from weight of solution absorbed. This difference is the weight of soluble matter drawn out.

ABSORBENT PROPERTIES OF TIMBERS, WEIGHT &C. (E)

Series No.	Kind of Timber	Where From	Heart or Sap	Weight per cu. in. ozs.	Weight per cu. ft. lbs.	Spec. Grav.	Moist at Com. % Vol.	Absorption in Vol. 3 Hours	6 Hours	24 Hours	72 Hours	7 Days	14 Days	30 Days	60 Days	Over 60 Days	Total at 30 Days
77	Sugar Tree.	Fox River	Both	.414	44.7	.717	Norm	--	--	.080	.143	.183	.290	.336	.365		
78	Hackberry	By H.D.	"	.370	40.8	.654	"			.069	.122	.167	.235	.290	.359		
79	White Ash.	Barber.Esq	HT.	.350	37.8	.606	"			.080	.135	.170	.218	.265	.333		
80	Hickory.S.B.	" "	"	.447	48.2	.774	"			.134	.165	.205	.242	.269	.318		
81	Sycamore.	" "	"	.379	41.0	.657	"			.259	.302	.308	.347	.366	.404		
82	Linden	" "	"	.253	27.3	.438	"			.301	.402	.419	.500	.526	.567		
83	Wild Cherry	" "	"	.420	45.4	.728	"			.059	.097	.114	.149	.170	.238		
84	Red Elm.	" "	"	.307	33.1	.532	"			.103	.165	.184	.207	.215	.259		
85	Mich. Pine.	S.M.R.(c)	"	.261	28.2	.452	"	.295		.352	.383	.433		.512			
86	" "(d)	" "	"	.261	28.2	.452	"	.341		.362	.375	.411		.477			
94	Cypress(g)	Whitmore	"	.331	35.7	.572	"				.221	.236	.243	.287			
95	" (h)	Greenville	"	.359	38.7	.621	"				.165	.193	.204	.206			
100	Rock Elm	C&N.W.Ry.	H&S	.440	46.9	.755	"				.110	.140	.168	.216			
101	Mexican P.	Tras Marius		.350	48.7	.621	"			.235	.263	.288	.328				
102	" "	" "		.254	27.5	.440	"			.110	.152	.208	.276				
103	"	Lacharia		.249	27.0	.433	"			.217	.281	.316	.340				
104	" "	Celaya		.265	28.6	.459	"			.103	.152	.227	.272				
105	Tinquindin	Yurecuaro		.270	29.1	.467	"			.194	.165	.218	.300				
106	"	"		.360	38.9	.624	"			.186	.244	.270	.291				
107	Oyamel P.	Celaya		.278	30.0	.481	"			.133	.168	.216	.283				
108	" "	"		.251	27.1	.434	"			.145	.186	.236	.325				

Saml M. Rowe

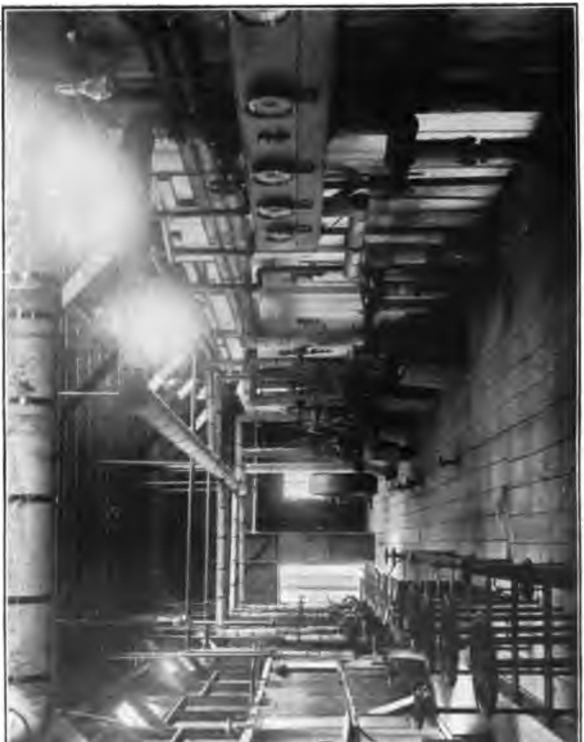
Chicago Jany 20th 1904.


FAIRBANKS, MORSE & CO.
SOLE SELLING AGENTS
SHEFFIELD CAR CO.

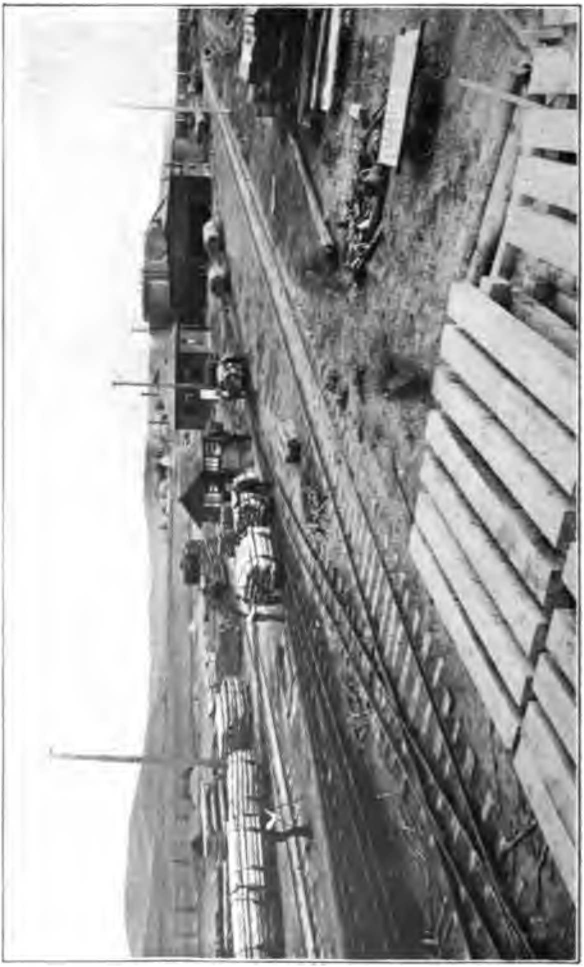
LAS VEGAS PLANT A. T. & S. F. R'Y.

ORIGINAL TWO-CYLINDER ZINC-TANNIN PLANT AT LAS VEGAS, N. M.

SIX-CYLINDER ZINC-TANNIN AND CREOSOTE PLANT AT SOMERVILLE, TEXAS.



MACHINERY ROOM, SOMERVILLE, TEXAS.



C., B. & Q WORKS, SHERIDAN, WYOMING.

EDGEMONT BURNETTIZING PLANT DURING ERECTION.

BURNETTIZING PLANT OF THE C., B. & Q., AT EDGEMONT, S. D.

MACHINERY ROOM, BELLEMONT, ARIZ.

TWO RETORT WORKS, SANTA FÉ PACIFIC, BELLEMONT, ARIZ.

MACHINERY ROOM, SOMERVILLE, TEXAS.

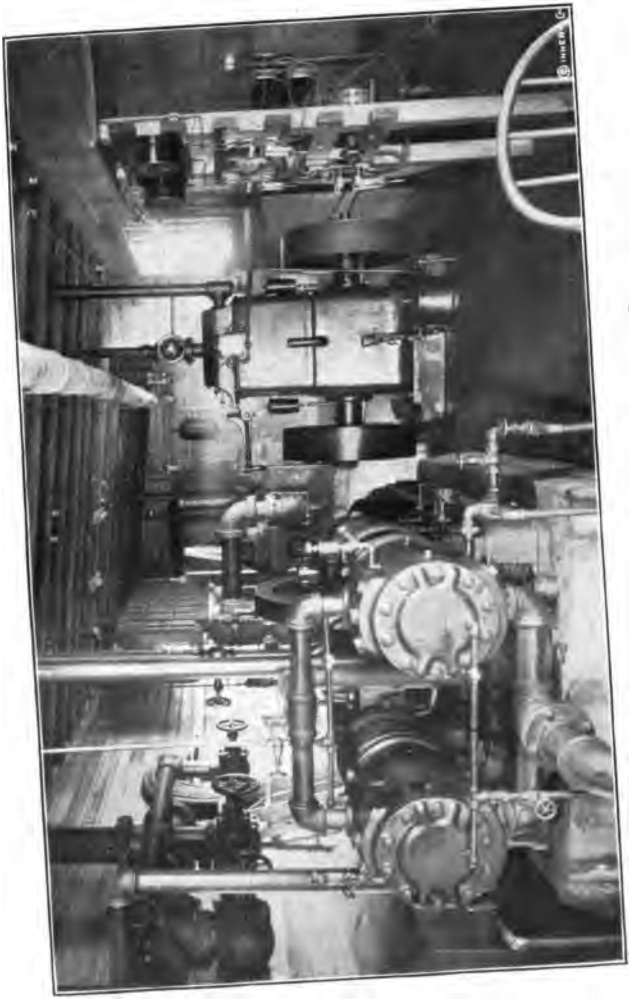
RETORT. U. P. AND O. R. & N CO.'S PORTABLE PLANTS. R. & R.

MACHINERY ROOM. G N. R'Y.

SOLUTION PIPES FOR THREE MOVEMENT PROCESS. G. N. R'Y.

G. N. WORKS DURING CONSTRUCTION.

C., B. & Q. RY.'S FORE YARD, SHERIDAN, WYOMING.



MACHINERY ROOM, SHERIDAN, WYOMING.

TWO RETORT WORKS, SANTA FÉ PACIFIC, BELLEMONT, ARIZ.

MACHINERY ROOM, SOMERVILLE, TEXAS.

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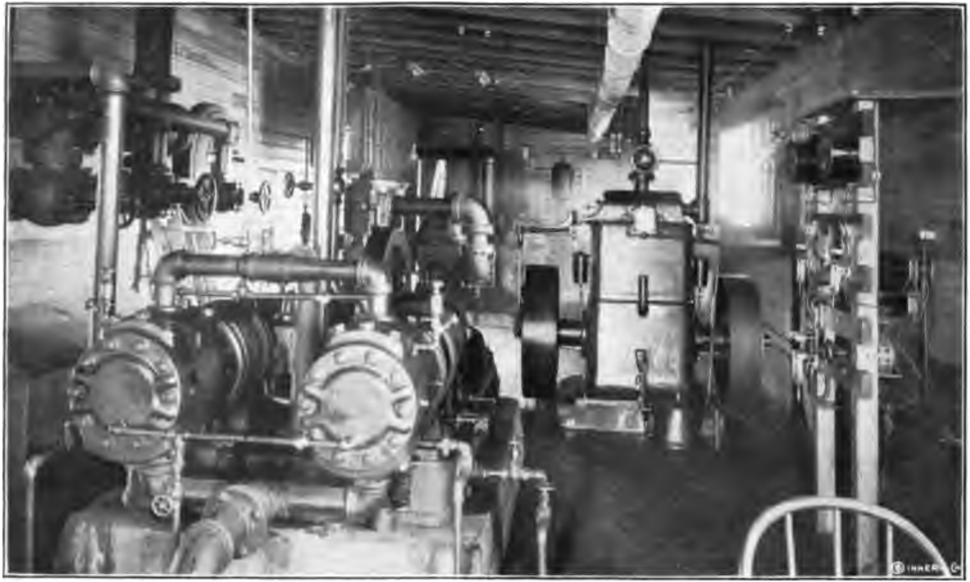
C., B. & Q. RY.'S FORK YARD, SHERIDAN, WYOMING.



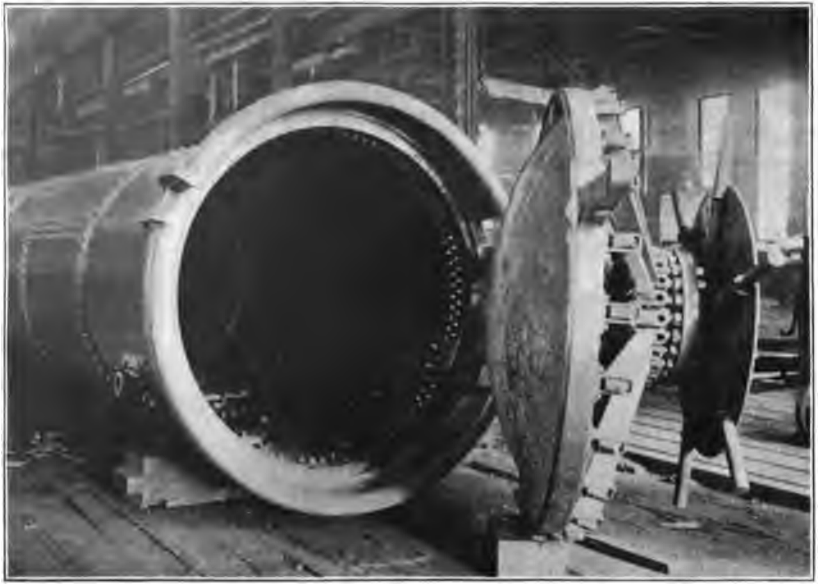
MACHINERY ROOM, SHERIDAN, WYOMING.

C. & N. W. RAILWAY WORKS, AT ESCANABA, MICH.

SOUTHPORT, LA. ENGINE HOUSE, TANK AND LOADING RACK, I. C. R. R.

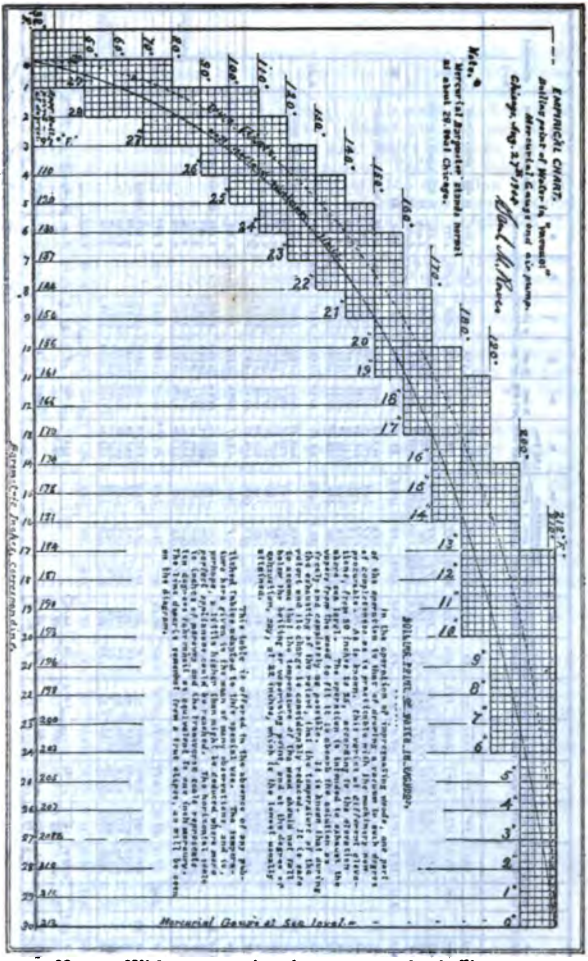
ST. LOUIS TIE CO. WORKS, 1880.

INSIDE VIEW OF TANK, SOUTHPORT, LA., I. C. R. R.



NO. 81647. DOOR FOR TIE PRESERVING CYLINDER.
ALLIS-CHALMERS CO., MILWAUKEE. BUILT FOR M. K. & T. RY.

NO. 81648. DOOR FOR TIE PRESERVING CYLINDER.
ALLIS-CHALMERS CO., MILWAUKEE. BUILT FOR M. K. & T. RY.



Note.—With more perfect instruments the boiling point is between the line given and the ellipse, perhaps very near the latter.

a.	b	c	d.	e	f	g.	h	i	j	k	l	m	n	o	p	q.	r.	s	t.	u.	Remarks	
										Temperature.												
No. Cer.	No. Ties.	Cu. Ft. Each	Wt. Bef. Treatm't	Wt. Aft. Steam	Wt. Aft. Vacuum	Wt. Aft. Treatm't	Gain Aft. Steam	Gain Aft. Vacuum	Gain Aft. Treatm't	Aft. Steam	Aft. Vacuum	Aft. Treatm't	Lbs. Sol. Injected Tank Mes.	% Inc. Aft. Sts.	% Inc. Aft. Vac.	% Inc. Aft. Treat.	Time Steamed	% in Solution	Seasoned	Kind of Timber	n − j.	
3307	7		950	981	940	1403	41	30	546	222.6	127		540.6	.042	.042	.378	3.500	1.350	40 days	[illegible]		
Mean	1	2.9	131.4	137.3	134.3	209.4	5.09	3.09	78	222.6	157		77.23	.045	.032	.348	2.500	1.750	" "	" "	0	
341	14		10896	11210	10832	13490	334	−4	2104	194	155	127.8	2049.5	.031	−.0004	.193	4.000	3.044	20 days	Sawed – Int. Pine		
345	"		11268	11605	11352	13040	337	74	1772	202.5	161	130	1414.5	.03	.0275	.154	"	3.666	15 "	" " "		
317	"		9942	10360	10070	11782	418	128	1273	205.5	140	141	1421.7	.042	.013	.178	"	3.166	30 "	" " "		
Mean	1	3.61	131.3	131.6	128.1	164.4	4.32	.72	22.38	200.6	153	136.2	23.11	.034	.0067	.178	4.000	3.611	25 "	" " "	.36	
361	39		4300	4514	4420	5572	214	138	1252	190	136		1643.24	.0491	.0274	.2412	5.000	4.416	12 weeks	Sawed – Douglas Fir		
337	"		4256	4444	4394	5216	318	168	1340	171	147	104	1497.14	.0516	.0296	.2774	"	4.416	"	" " "		
344	"		3740	3960	3904	5600	216	164	1760	196	150	146	1683.24	.0573	.0459	.4473	"	4.333	"	" " "		
351	"		4056	4374	4252	5466	318	196	1410	206	132	153	1671.54	.0724	.0453	.3470	"	4.416	"	" " "		
355	"		3900	4016	3990	5512	216	180	1672	207	150	146	1669.54	.0562	.0441	.4324	"	4.333	"	" " "		
359	"		3766	4075	4000	5566	214	136	1744	205	160	154	1636.73	.0554	.0340	.4400	"	4.381	"	" " "		
Mean	1	3	103.45	107.66	106.66	141.42	2.94	3.19	37.54	197.5	152.3	149.6	48.51	.0585	.0311	.3821	5.000	4.375	"	" " "	4.87	
351	39		4350	4540	4430	5614	280	110	1254	194	156		1603.24	.0509	.0255	.2942	"	4.416	Green	Sawed – Douglas Fir		
337	"		4760	4581	4576	5766	178	116	1186	171	155	148	1497.14	.0374	.0243	.3323	"	4.416	"	" " "		
346	"		4414	4642	4566	5466	228	152	1046	199	158	145	1603.24	.0516	.0344	.3270	"	4.333	"	" " "		
351	"		4450	4706	4540	5960	256	148	1414	206	150	150	1611.54	.0576	.0315	.3134	"	4.416	"	" " "		
357	"		4742	4926	4702	6066	194	100	1324	205	150	146	1664.54	.0604	.0311	.2756	"	4.333	"	" " "		
359	"		4540	4765	4660	5764	204	109	1205	201	154	152	1636.73	.0447	.0314	.2607	"	4.383	"	" " "		
Mean	1	3	116.41	121.96	119.53	147.97	3.47	3.06	31.55	197	148	149	43.51	.0472	.0365	.3310	5.000	4.375	"	" " "	11.96	
364	30		3450	3600	3544	4304	170	124	854	192	170	146	1137.50	.0536	.0365	.3575	"	3.513	12 weeks	Hewed – Pine		
373	"		3314	3436	3430	4437	158	110	1184	190	154	138	1665.30	.0477	.0332	.3341	"	4.083	"	" "		
373	"		3385	3472	3456	4386	184	71	1010	194	160	130	1640.60	.0370	.0232	.3514	"	3.500	"	" "		
376	"		3420	3595	3528	4702	161	102	1316	205	164	144	1208.00	.0491	.0300	.3749	"	4.416	"	" "		Treated with Fir.
376	"		3456	3640	3566	4524	124	110	1065	201	170	158	1308.00	.0432	.0318	.3090	"	4.416	"	" "		
Mean	1	3.67	113.12	117.55	116.59	140.90	5.4	3.49	36.92	200	164	142	51.75	.0479	.0309	.3366	5.000	3.999		" "	14.83	
364	30		4808	4870	4904	5540	91	−7	1021	170	152	144	1137.50	.0159	−.0019	.3047	"	3.583	Green	" "		
373	"		4648	4514	4492	5556	46	−36	1088	174	148	138	1665.30	.0170	−.0008	.2435	"	4.083	"	" "		
376	"		4766	4792	4712	5794	26	−54	1028	188	150	130	1644.60	.0055	−.0113	.3137	"	3.500	"	" "		
376	"		4818	4916	4736	6094	−2	−92	1176	196	157	146	1208.00	−.0004	−.0187	.2991	"	4.416	"	" "		Treated with Fir.
376	"		5006	4974	4878	6034	−28	−132	1027	201	160	132	1308.00	−.0026	−.0265	.2835	"	4.416	"	" "		
Mean	1	3.67	140.36	141.14	139.48	176.06	.74	−2.1	35.61	176	150	142	51.75	.0061	−.0129	.2227	5.000	3.999	"	" "	16.14	
378	427		45354	50130	49110	65046	3476	1838	17212				33164	.0577	.0319	.3567	5.000	3.500	12 weeks	[illegible] Pine		
Mean	1	3.67	112.76	117.39	116.81	152.37	5.84	3.27	40.31				78.35	"	"	"	"	"	"	" " "	13.84	
[illegible]																						
373	30		4766	4795	4712	5794	26	−54	1027					.0696	.0113	.3127	5.000	3.500	Green	" " "		Car No. 6
Mean	1	3.67	158.86	159.73	157.06	193.13	.37	1.8	34.28				54.35	"	"	"	"	"	"	" " "	20.02	" "

Chicago, Apr. 28th 04 Saml. M. Rowe.

The table here given is results of investigation made by the aid and co-operations of three operators of Timber Preserving Plants, F. J. Angier of Sheridan, Wyoming, H. J. Whitmore of Granville, Texas, and F. H. Stewart of Alamogordo, New Mexico, at request of the author. The primary purpose was to determine as near as possible just what takes place as regards physical conditions during the operation. Each one, aside from the program furnished, carried through the operation entirely independent of each other and the uniformity of mean results, fully attest the care and ability with which each conducted the experiment.

One question recently brought to the front by the theorist, has been the amount of heat attained by the timber during steaming and vacuum, it being urged that during the producing the vacuum, the temperature of the steamed timber became reduced, so that a portion of the vapors in the timber would again condense and thus fail to be drawn out. It is, therefore, urged that a coil of superheated steam should be used to keep the temperature above the vaporizing point until the vacuum was fully drawn.

Now let us see: In any case the vacuum drawn is never less than 22 inches and at this point water boils at 140° Fahr. against 212° at atmospheric pressure. Referring to the table, we find that the mean temperature at completion of the vacuum is 158° F., and the minimum 135°, nowhere as low as the boiling point in 22 inches vacuum, except in one run. It would seem, therefore, that a superheater coil is not needed.

Another point brought out is, that during the steaming the boiling point is reached in a majority of cases, allowing for the elevation above the sea and the imperfect method resorted to, that of withdrawing the car and pushing the thermometer into a hole previously prepared.

Then again, it will be noted that dry ties age almost invariably heavier after the vacuum is drawn by about 4 per cent, and green ties are lighter by about 2 per cent, than when introduced and that some very green are slightly lighter after steaming and before the vacuum is drawn. This is due to the large amount of water boiled out during the steaming, overbalancing the steam absorbed.

There are other significant matters brought out that will interest the experienced operator, and will, it is hoped, encourage further investigation in this direction.

Referring to matter of saps drawn from the wood as per page 180 (Hand Book, the column R.-J), is significant where none is shown in very dry ties, whereas very green ties give off over 20 lbs. per tie.

TREATED TIES. C.R.I.&P. RY.

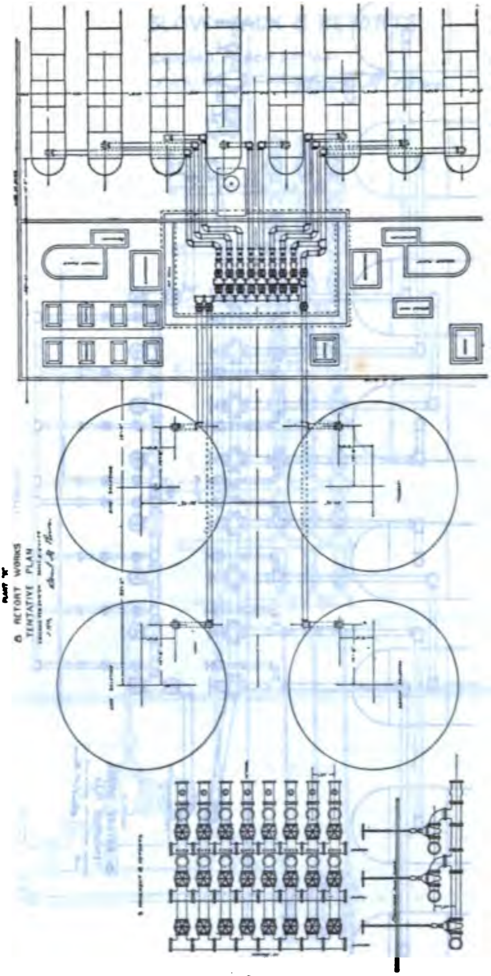
	Year.	A	B	C	Year	C. Equalized	C.Σ Accumulated	$\frac{C.\Sigma}{B}$
1	1886.	101.164	101.164	2.133	6TH	2.133	2.133 *	.0210
2	1887	262.317	363.481	12.736	7TH	12.736	14.869	.0403
3	1888	196.569	560.050	33.344	8TH	33.344	48.213	.0862
4	1889	204.519	764.569	62.245	9TH	52.245	100.458	.1445
5	1890	225.974	990.543	71.695	10TH	81.695	182.150	.1833
6	1891	315.142	1.305.685	137.708	11TH	117.708	299.864	.2296
7	1892	310.613	1.616.298	160.354	12TH	140.354	440.218	.2724
8	1893	305.287	1.921.565	185.803	13TH	185.803	626.021	.3247
9	1894	320.314	2.241.879	221.369	14TH	231.369	857.386	.3824
10	1895	142.961	2.384.840	249.803	15TH	249.803	1.107.188	.4643
11	1896	83.639	2.468.479	1.107.196				
12	1897	100.583	2.569.062					
13	1898	53.164	2.622.226					
14	1899	168.474	2.790.700					
15	1900	163.172	2.953.872					
16	1901	215.989	3.169.861					
	TOTAL	3.169.861						

*As no ties come out until the sixth year it seems evident that the 2133 were from those laid in 1886 and so on to the year 1895. The number removed all therefore come from the first ten years, amounting to $46\frac{43}{100}$ % leaving $55\frac{57}{100}$ % still in. Meaning a mean life of 11.5 years.

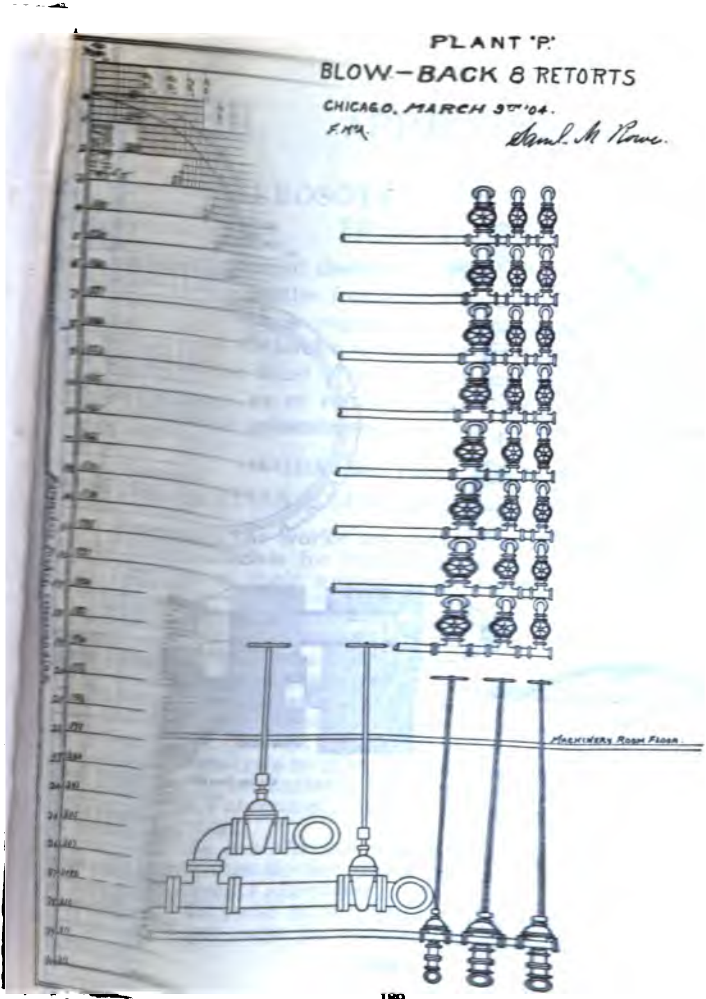
NOTE:- A, Number of ties laid in each year and C, the number removed

CHICAGO, MAY 12TH 1904.

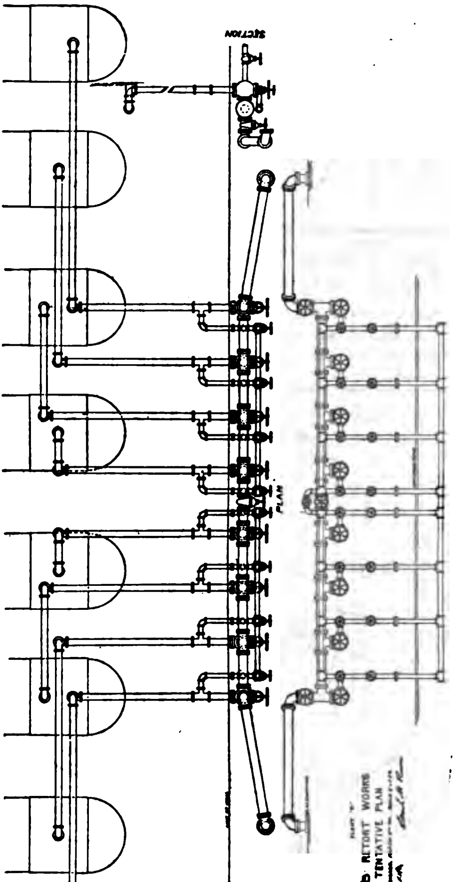
[signature]



RETORT WORKS
TENTATIVE PLAN



Note —
between
latter.

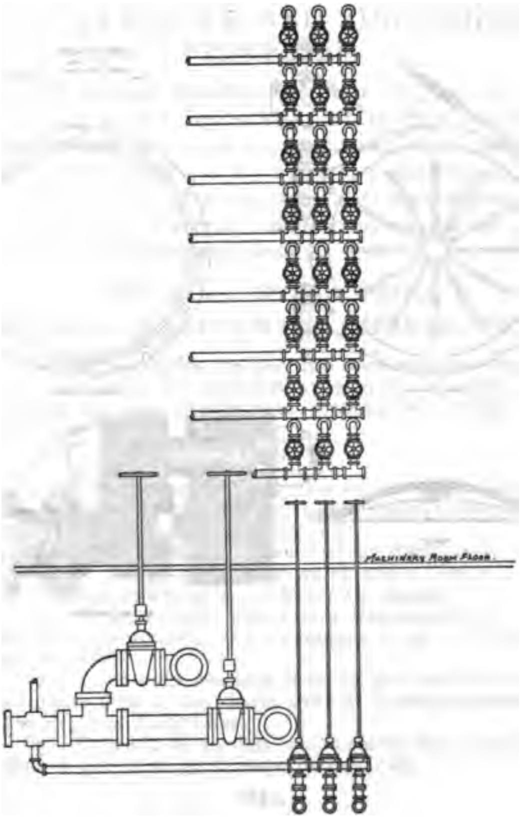

SECTION
PLAN
ELEVATION
RETORT WORKS
TENTATIVE PLAN

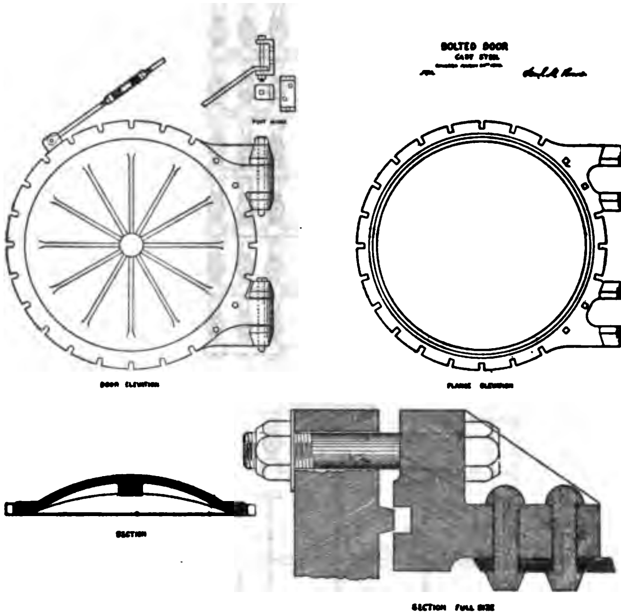
PLANT "P."

BLOW.-BACK 8 RETORTS

CHICAGO, MARCH 9th '04.

F.M.M.　　　Saml. M. Rowe.

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CAST STEEL
DOOR ELEVATION
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SECTION FULL SIZE

APPENDIX.

THE CREOSOTE AND ZINC-TANNIN PROCESSES.

It is deemed desirable that place be given to the following matter from one of the best, if not the best, posted men in regard to the matter here treated. OCTAVE CHANUTE, C. E., has that extended experience that must give his statements such degree of authority as to remain undisturbed except by the very best substantiated proofs.

WORKING INSTRUCTIONS.

MATERIALS NEEDED FOR IMPREGNATION.

Before the works are put into operation the necessary materials for injection have to be ordered and placed in their appropriate receptacles. Order as follows:

CREOSOTE.

Order in the ratio of 1½ gallons per cubic foot of the quantity of timber which it is intended to creosote and to the following specifications:

"The creosote to be a pure coal tar distillate of the very best quality, free from water and all impurities, and on analysis to give the following results:

"1. To be entirely liquid at a temperature of 120 degrees Fahrenheit, and to remain so on cooling to 95 degrees.

"2. To contain not less than 25 per cent. of constituents that do not distill over at a temperature of 600 degrees Fahrenheit.

"3. To yield to a solution of caustic soda not less than 6 per cent by volume of tar-acids.

"4. The specific gravity at 90 degrees Fahrenheit to range between 1.040 and 1.065, water being taken as 1.000 at the same temperature."

This is the English specification, and London governs the price for creosote all over the world. The firm of Burt, Boulton & Maywood are large dealers in England, and the Barrett Manufacturing Co. lead in the United States. The price fluctuates greatly.

The creosote will probably be received in barrels; these should be rolled over a gangway to the creosote storage tank and dumped therein. The oil will probably be fluid, but if it does not flow easily, a closed steam lance with flexible steam connection inserted into the barrel will cause its rapid emptying. From the storage tank the oil will be transferred by gravity or pumping in needed quantities to the creosote reservoir, under the retort.

Steam coils are placed in the creosote storage tank, in the creosote reservoir in the retort, and in the measuring tank if one is used. In addition to this, the main pipes connecting these various receptacles have a small internal pipe through which steam or its condensations circulate in order to keep the creosote hot and prevent clogging.

The tests of the creosote received will have to be made from time to time by a chemist, and it is recommended that he shall procure a copy of the book by Lunge, "Coal-Tar and Ammonia."

CREOSOTING.

This process consists of three operations:

1. Steaming the timber.
2. Producing vacuum and admitting creosote.
3. Application of pressure pump.

I. STEAMING THE TIMBER.

The timber being in the hermetically closed retort is first subjected to the action of steam, unless the wood is so thoroughly seasoned as not to require this. The time necessary for steaming depends upon the season and the kind and condition of the wood.

The object of this steaming is to put the timber in a condition to absorb the greatest possible amount of the preserving fluid, by dissolving and removing as much of the sap as possible, as well as whatever dirt there may be on the faces of the wood.

The admission of steam to the retort is to be so regulated that the gauge attached thereto shall indicate a steam pressure of 20 pounds at the end of not less than 30 minutes after beginning the process. This steam pressure is then to be kept up, without increase, for a further period, varying from 30 minutes to three hours, in accordance with the condition and kind of the wood. The greener it is the longer must the steaming be continued to extract the sap. The denser the wood the more does it require long steaming in order that the sap in the heart of the timber shall reach the boiling point. Very dense woods, with small and infrequent sap cells, should not be treated at all, as this will be a waste of money. The fact may be determined by weighing thoroughly seasoned specimens and rejecting the woods which weigh 50 pounds or more to the cubic foot when in that dry condition, or over 55 pounds to the cubic foot when half seasoned. Experience will have to guide.

In order to expel the air from the retort at the beginning of the steaming, a valve attached to the lower part of the retort must be opened until steam begins to escape; this valve must also be opened from time to time, or left with a very minute opening during the process of steaming, in order to draw off the water of condensation.

After steaming the wood for a sufficient length of time, the steam is allowed to escape from the retort. The steam valve and all escape valves are then closed before proceeding to pump a partial vacuum.

2. PRODUCING VACUUM AND ADMITTING CREOSOTE.

After the steam is exhausted from the retort, a vacuum of 18 to 24 inches of mercury, as indicated on the vacuum gauge, is produced, and this amount

of rarefaction must be kept up from 10 minutes to one hour, as experience with the kinds of wood operated upon shall indicate. Then, without decreasing the vacuum, i. e., without stopping the air pump, the creosote, previously heated to 120 degrees F., is admitted. This is done by opening the valve leading to the creosote reservoir under the retort, when the fluid rises through the action of atmospheric pressure, so as to fill the retort partially, the remainder of the filling and the application of pressure are effected by means of the pressure pump.

3. APPLICATION OF PRESSURE PUMP.

The pump is to be put into and continued in action until the pressure is raised to 100 pounds to the square inch, and this must be maintained, until the requisite amount of creosote has been forced into the timber, the air pump being shut off as soon as it is ascertained that the retort is full of creosote. The time requisite to produce absorption by the wood will vary from 30 minutes to three hours, and the amount to be injected will vary from ten pounds to the cubic foot for timber to be exposed only to the weather, to sixteen to twenty pounds per cubic foot for timber to be exposed in the sea to the action of marine worms, i. e., the Teredo Navalis or the Limnoria Terebrans. If necessary the time of pumping must be prolonged until the required amount of creosote has been absorbed.

In order to determine the amount of oil absorbed by each charge, two methods are employed. The first is to read accurately the gauges or indicator boards attached to the creosote tank and the creosote reservoir before and after the injection of the timber. From these readings the amount of oil absorbed by the charge is computed, and knowing the number of cubic feet in the charge the quantity per cubic foot is easily ascertained. If through any cause it is impracticable to measure beforehand the volume of charge, the amount of cubic feet which it contains may be ascertained approximately by

first gauging the cubic contents of the retort with only the empty buggies and the wire rope therein; then by reading the gauges, first, before admitting the creosote: second, when the retort is just full. and, third, after the creosote has been forced back; the displacement of the charge in cubic feet may then be computed, as more fully explained hereinafter.

The second method of determining the amount of oil absorbed by each charge is to weigh each buggy load just before and just after creosoting; the difference showing the weight absorbed, and this is presumably evenly distributed among the number of cubic feet in that buggy charge. This is probably the more accurate way, but it requires the introduction of a weighing scale in the track, or the handling and weighing of each piece of timber separately. In computing the result, the amount of sap previously extracted by the vacuum must be taken into account, and be added to the increased weight shown by weighing. This extracted sap can be measured through the hot well of the condenser, and its weight thus ascertained.

In case of any charge in which the timber fails to absorb the requisite quantity of creosote, the process may be repeated. The tar-oil, or creosote, is to be kept at a temperature of at least 120° F. during the whole operation of injection.

After the requisite quantity of oil has been absorbed by the timber, and this may be most accurately determined by adding a measuring tank to the works, the tar oil is then drawn off.

CREOSOTING.

The creosote or "dead oil" is to be stored in a metal tank (iron or steel), in which is placed a steam heating coil to bring and keep the oil at such temperature as shall be necessary to keep it entirely fluid or liquefied (say, 120 to 130 deg. F.).

The suction pipe of the pump by which the oil is to be handled enters the side of the store tank and has its inlet very near the bottom, by means

of which the oil is drawn to the pump and by it forced into the reservoir placed immediately under the retort or into the retort itself as during pressure on the charge.

The reservoir is also furnished with a heating coil by which the temperature of the oil is still further raised to such temperature as may be found desirable, not so high as to prevent or destroy the vacuum in the retort by which it must be caused to flow into the retort.

In case the vacuum should fail to fill the retort around its charge, then resort must be had to the force pump to fill the remaining by drawing preferably from the storage tank, although if the reservoir contents are not too hot, from it. This as well for creating proper pressure on the charge during its exposure to the oil.

INTRODUCING THE CREOSOTE TO THE RETORT.

The charge having been carried through the steaming process, the same as done in section 1 for the zinc-tannin process, and the vacuum drawn and held for the desired time to exhaust the freed saps from the timber, the creosote is allowed to flow up through the five-inch valve and connecting pipe joining the reservoir with the bottom of the retort by opening the valve "R," and at the same time opening an air pipe with which the reservoir is to be provided in order that atmospheric pressure shall act on the liquid in the reservoir, which should lift so much of it as will fill the retort, the full force being kept up by continuing the use of the vacuum pump.

When the retort is filled as nearly as practicable, then the valve "R" should be closed, the vacuum pump stopped and the pressure pump immediately started and the remaining space in the retort filled and pressure brought on the charge, preferably drawing from the storage tank, as this will tend

to keep up the supply and replace the amount absorbed by the timber.

DURING EXPOSURE OF CHARGE TO THE OIL.

When the charge is all in and the pressure pump in operation, steam is turned on the heating coil in the retort and the temperature of the oil is raised to that prescribed, say 170 to 190 deg. F., and so held until sufficient absorption is had, which being done, the residue of oil is allowed to flow back into its reservoir through the pipe and the valve "R" through which it entered. The charge of timber is allowed to drip until quite free from the clinging oil, the operation is complete and the charge is withdrawn.

OPERATION OF THE HEATING OIL.

The store tank, the reservoir and the retort have each its independent steam supply pipe from the main steam pipe in the machinery room, with a valve in each, convenient to the hand of the engineer by which each coil is operated as needed, and the outlet of condensations leading from each coil, enter one common steam trap, which in its turn has a discharge pipe leading to the hot water reservoir or the boiler feed tank, as may be desired. The operator should be guided by the necessities, being indicated by the thermometers placed upon the storage tank, the reservoir and the retort.

Read the gauges and the indicator boards at the proper times, and also the glass tube of the hotwell to the condenser, and fill out the blanks in the report of run.

Much of the knowledge necessary to be entirely successful must be derived from experience and a considerable exercise of judgment and careful observation. As regards the matter of temperature of oils or solutions, strength of solutions, time, steam or pressure shall be held and many other pertinent

matters; this depends so largely on the character of timber to be treated, to climatic conditions and to the specifications and methods to be used, that it would be impossible to explain this through the present means, and it can only be done by an experienced operator on the ground.

CHLORIDE OF ZINC.

The chloride vats are lead lined, so that the chloride can be made on the spot by pouring hydrochloric acid over metallic zinc (spelter) in case those materials can be procured, but it is assumed that it will be preferred to use the "fused chloride of zinc," which comes in iron drums. Order the latter in the ratio of one-half pound per cubic foot of the quantity of timber which it is intended to treat therewith. Fused chloride is made by a number of firms in Germany, which are well known to the chemical agencies, and by one or more firms in the United States.

A convenient way of handling the drums will be to roll them over the gangway above the chloride vats, there to chop off the sheet iron, which is quite thin, with an axe, and to chop the chloride into suitable pieces to throw into the vats, using each alternately. By adding about the same weight of pure water as there is of the chloride and letting it stand a day or two, this dissolves into a "stock solution," which should read about 50 degrees with the Beaumé hydrometer. From this "stock solution" appropriate quantities are to be thrown up by the steam jet into the chloride storage tank, to produce the strength of "working solution" desired, which will vary probably from 2° to 5° Beaumé, in accordance with the condition of the timber to be treated, as more fully stated hereafter. When the general conditions of the working have been arrived at, much labor of computation will be saved by preparing a table showing how many tenths of feet from the chloride vat, should be mixed per foot of water in

the storage tank in order to produce the strength of "working solution" required.

The testing of the chloride of zinc will have to be made from time to time by a chemist. It should be as free as possible from impurities, and especially from iron. The chemist will indicate what simple tests can be applied at the works to test for iron, free acid, sulphates or basic chloride when he is not present.

GELATINE.

Order dry glue in the ratio of 1-10 of a pound per cubic foot of the quantity of timber which it is intended to treat by the zinc-tannin process (somewhat less will be used). If moist glue is to be had, order twice the above quantity, as it contains about 50 per cent of water. It is not requisite that the glue shall be refined and the cheaper grades will answer very well, provided they are rich in gelatine. This is to be ascertained by testing a sample dissolved to a syrup between the fingers, and noting its degree of adhesiveness, and also by making a solution 2 per cent strong and mixing in a test tube with a solution of tannin of the same strength. The glue which will yield the largest volume of pellicles of insoluble artificial leather is the best to use.

The glue is to be dissolved in the appropriate cooking tub with hot water (best obtained by steaming) into a "stock solution" of convenient strength, whence it is to be thrown up by the steam jet into the gelatine storage tank so as to produce a "working solution" 1 per cent strong, in terms of dry glue. The exact strength is not essential, as the office performed by the gelatine and the tannin is to produce pellicles of an insoluble substance which obstructs the washing out of the chloride of zinc.

TANNIN.

Order liquid extract of tannin in the ratio of 1-10 of a pound per cubic foot of the quantity of timber which it is intended to treat by the zinc-tannin proc-

ess (somewhat less will be used). The most suitable is the extract of hemlock bark which is made in Pennsylvania and in Michigan, and which contains about 30 per cent of tannic acid (in terms of oxalic acid), and is sold by the pound. It is practicable, however, to use other varieties of tannin, such as extract of oak-bark, of willow bark, or of chestnut, catechu, sumach or gambier. If tannin containing barks are to be obtained locally it may be cheaper to make the extract on the spot, the essential point being that the "stock extract" shall contain about 30 per cent of tannic acid, in terms of oxalic acid. This "stock extract" is to be emptied into the appropriate cooking tub, steamed, and thrown up by the steam jet into the tannin storage tank in such quantities as to form therein a "working solution" containing 2 per cent of the tannin "stock extract." The exact proportion is not essential and a little practice will enable the operator of the works to get at the correct proportion of water to be added to obtain a "working solution."

CONDITION OF TIMBER.

The condition of the timber before treatment is the most important element of success. The wood should be seasoned, or at least half seasoned, and this can best be ascertained before beginning operations by measuring and weighing samples of wood, two or three cubic feet in contents, when fresh cut and when thoroughly seasoned, so as to ascertain their weight per cubic foot. The difference between the two weighings will indicate the amount of the watery portion of the sap which has evaporated, and of the amount of solution which can probably be injected; this serving as a guide in selecting those woods which should preferably be employed. After these datas have been obtained, experience will guide as to the length of time and the mode of seasoning which are requisite to obtain good results. In Europe wood is seldom treated before it has been seasoned from 6 to 12 months. In the United States

wood is generally treated some 4 to 6 months after it has been cut, but the results are inferior; save on the Pacific Coast, where it is said that Oregon fir seasoned in the air 2 years will take double the time for treatment which is required for one freshly cut. This probably results from the presence of resin in the wood, which gums upon seasoning.

PREPARATION FOR WORKING.

The first requisite is that the engineer who is to operate the works personallv shall thoroughly know and understand all parts of the plant. The retort, the working tanks, and especially the piping and valves, so as to know what motions to make to produce certain results. After he has made adequate studies of these and the tanks have all been charged with the liquids of the requisite working strength, the operation consists essentially in the following actions:

1. Charging buggies, placing in retort, closing door.
2. Steaming not over 20 lbs. pressure.
3. Producing vacuum of 18 to 24 inches.
4. Introducing solutions and applying pressures.
5. Forcing surplus solutions back into tanks.
6. Opening door of retort and withdrawing charge.

The details for these actions are given under the appropriate headings in the instructions to the engineer, but general instructions for some of them are as follows:

I. CHARGING BUGGIES, ETC.

The loads on the buggies should fit the interior of the retort as completely as practicable. This is best attained with green operatives by using the index frame, with rotating arms, which will sweep the circle of permissible loading when placed on the track against the buggy. In a short time the men will learn to do without it. Care should be taken that the loads should present square faces front and rear

on the buggies, as they are to be switched about with the wire rope attached to the rear buggy, all the others being pushed by it. When hauling the load into the retort the "pulling in" rope attaches to the last buggy, passes into the retort, and through the hand hole and sheave to the winch, while the "pulling out" rope is attached to the then front buggy, is dragged in with the train, and remains in the retort during the treatment, ready to be fastened to after opening the door.

The door is closed by inserting and screwing up the hook bolts, going over them, round after round, to ensure even pressures. Before closing the door the packing in the groove is to be lightly gone over with moistened soapstone powder to prevent sticking. The door is opened by unscrewing the bolts. Some practice is required to avoid leakages, the insertion of the packing being an operation which must be carefully done.

2. STEAMING.

The pressure gauge and the thermometer are to be carefully watched during the steaming, as the pressure may not be allowed to go over 20 pounds to the square inch, and the temperature over 240 degrees Fahrenheit, without danger of injuring the strength of the wood. The length of steaming will vary with the condition of the wood, and must be obtained by experience. In the case of thoroughly seasoned wood (an article which will seldom be treated) the steaming can be omitted altogether with profit.

3. PRODUCING VACUUM.

The air pump produces both pressure and vacuum. The latter is employed to exhaust the air and sap from the wood, and should range from 18 to 24 inches of mercury, in accordance with the condition of the wood, and the amount of solution it is desired to inject. The higher the vaccum the better the wood is prepared. The amount of vapor pumped

out of the retort and condensed in the condenser is measured in the hot well under the latter, and read off in the glass tube. If creosoting, the condensed vapor is saved, if working the zinc-tannin process it is run to waste.

THE ZINC-TANNIN PROCESS.

This process consists of five operations:

1. Steaming the timber.
2. Producing a vacuum.
3. Admitting chloride of zinc. Pressure.
4. Blow back, admitting gelatine. Pressure.
5. Blow back, admitting tannin. Pressure.

The steaming of the timber and the vacuum are to be carried out in exactly the same manner as for creosoting, and the remarks already made will apply.

The third operation consists in admitting the chloride of zinc solution, previously heated to 150° F., from the chloride storage tank, and in applying pressure with the zinc pump. The time during which this pressure is to continue will vary with the condition of the timber, but will generally be two or three hours, during which the pressure must be maintained at 100 pounds to the square inch, watching the gauge, and regulating the pump. When the wood has been fully injected the chloride solution is to be forced back with compressed air into its tank. The strength of the solution should generally be 3.5° Beaumé. If the timber is refractory this may be increased to 5° Beaumé.

4. BLOW BACK ADMITTING GELATINE PRESSURE.

The chloride of zinc solution having been forced back from the retort, the gelatine is next admitted, and upon this a pressure is applied of 100 pounds to the square inch for 30 to 60 minutes. The wood has already been filled with the chloride of zinc, but upon the removal of its pressure a certain portion has been driven out by the re-expanding of the air included in the sap cells, thus making some room

for the gelatine. This penetrates perhaps one inch, under the renewed pressure, but a portion of this is again driven out by re-expanding, thus making room for the fifth operation.

5. BLOW BACK, ADMITTING TANNIN. PRESSURE.

The gelatine having been forced back into its appropriate tank, the tannin is next admitted, and pressure is applied of 100 pounds to the square inch by the pump, for 30 to 60 minutes. This penetrates from ½ to ¾ of an inch, and on coming into contact with the gelatine forms an insoluble substance which obstructs the dragging out of the chloride of zinc during the alternate soaking and drying out of timber when exposed to the weather.

This last operation having been performed, the tannin is forced back into its tank and the treatment is completed.

The time occupied by these various operations as carried out at works in Chicago is as follows:

	Hours.	Min.
Charging two retorts with ties (read tank gauges)	0	30
Producing steam pressure to 20 lbs. (read steam gauge)	0	30
Maintenance steam pressure (read thermometer)	3	—
Blowing off steam	0	15
Working vacuum pump to extract sap	1	—
Admission chloride solution (red indicator)	0	30
Duration pressure on solution (read indicator)	8	—
Forcing back chloride solution (read indicator)	0	20
Admission gelatine solution (read indicator)	0	15
Duration pressure on gelatine	1	—
Forcing back gelatine solution (read indicator)	0	15

	Hours.	Min.
Admission tannin solution (read indicator)	0	15
Duration pressure on tannin	0	30
Forcing back tannin solution (read indicator)	0	20
Discharging the retorts	0	20
	—	—
	12	—

The time of these various operations may be somewhat varied, and can be shortened to 8 hours if the timber is well seasoned. In Europe, where the wood has been seasoned 6 to 12 months, the treatment with chloride of zinc (omitting gelatine and tannin) is done in about 5 hours. It is desirable to arrange the time occupied so that the discharging and recharging the retorts shall be done when the timber handlers are at hand to help. The works are generally run night and day.

CHECK OF WORK DONE.

The most accurate way of checking off the work done is to weigh each buggy load just before and just after treatment. The difference in weight shows the number of pounds of solution injected, and as the strength of the chloride of zinc solution is known before hand, the amount of dry chloride injected is computed by multiplying the weight by the percentage corresponding to the degrees Beaumé. The following table gives those percentages:

PERCENTAGES OF ZINC CHLORIDE.

Fractional degrees may be obtained by interpolation.

This method involves putting a track scale at some convenient point, and passing every buggy over it, stopping long enough to weigh it, and recording the results in a book. The buggies have also to be identified at each weighing, and tabular statements have to be made of the results. All

this takes time, and costs something for labor, so that it is somewhat cheaper to rely wholly upon the records of gauging kept by the engineers, which should be kept in any event, and which may serve as a further check upon the weighing, should the latter be done.

The operating engineer is to keep a record about as follows. It may be modified to suit circumstances:

RECORD OF OPERATIONS.*

From which record the results may afterwards be entered into a book under such headings as may be deemed most desirable.

The left-hand set of blanks gives a record of the time of each operation, and the right-hand set gives the data for calculating the results.

The computations are made in this way:

The retort has previously been gauged with the empty buggies and "pulling out" wire rope inside, and it is therefore known how many cubic feet it contains when in that condition. This will be about 1,210 cubic feet. The reading of the index or indicator on the zinc chloride tank has been taken at the beginning of the operation, thus showing how many vertical feet there are in the tank. The "return point" of this indicator has also been read after the chloride has all been forced back. Hence the difference between those two readings will show how many vertical feet from the tank have been absorbed by the wood, and this multiplied by the number of square feet per foot of tank, which will be 113.10, if it is just 12 feet inside diameter, will give the number of cubic feet of solution which has gone into the wood. From this the pounds of solution, or pounds of dry chloride, may be deduced by applying the appropriate factors.

To arrive at the cubic feet displaced by the charge, it is necessary to deduct the reading of "lowest point indicator" from the "return point indicator"; the difference, multiplied as before by the

*See page 78.—AUTHOR.

square feet of area, gives the number of cubic feet which the retort still contained after the wood had been injected, and by deducting from this the number of cubic feet which the retort holds when only empty cars are therein, we obtain the displacement of the load in cubic feet; from which the pounds of wood may be calculated by applying the proper factor. Both calculations will be greatly shortened by preparing tables corresponding to each vertical foot of tanks, after the latter and the retort have been accurately gauged.

The amount of gelatine and tannin solutions absorbed may be computed in the same way, but there is little interest in doing so, as the chloride of zinc is the real preservative.

The data for each run should subsequently be entered in a book, in such order as the nature of the work requires.

CREOSOTING TIMBER.

DESCRIPTION OF OUR PROCESS.

"CREOSOTING."

"The timber is first loaded on cars and run into cylinders which are then hermetically sealed with immense iron heads. Steam is then admitted into the cylinder and surrounding the timber. Superheated steam is also introduced into the cylinders by means of large coils so that it does not come in contact with the timber, and the heat is maintained until the timber is heated all through at a low temperature so as not to injure the woody fibres. The cylinder is then freed of all vapors, and the vacuum pumps are put to work to exhaust all the sap and moisture, which is then in the shape of vapor, from the cylinder. Heat is maintained in the coils to prevent the vapor from condensing and thereby remaining in the timber. As the vacuum pumps are constantly removing the hot vapor from the timber it is absolutely necessary to keep the heat above the condensing point. To do this requires practical experience and means of knowing what such heat is, and as said before, those two parts of the process are the most important, and if properly done, the oil will be readily forced into the timber. After this has been done the oil is admitted into the cylinders while they are under vacuum, and when all air has been withdrawn they are subjected to pressure until the requisite amount (which is determined by correct gauges and thermometers) has been forced into the timber, which, if the timber has been properly prepared, is only a small part of the process, but if this has not been well done, the oil cannot be put into the timber. The cells of healthy timber are full of different substances, which, when subjected to heat, can be changed into vapor, and, unless the vapor has been completely removed, you

cannot force the oil into the timber, no matter how long the pressure has been applied. It is only by practical knowledge and delicate instruments that we determine when the heat has reached the center of the timber, and the vapor there formed has been removed.

"There will be no decay in any part of the timber that has been permeated with the oil, but to have all parts saturated is expensive and useless; for, after the timber has been thoroughly treated by the heat and vacuum process, it will last a long time without any oil, and if the crevices and pores are sealed up with the oil to a sufficient depth, the timber is as good as if the whole part has been thoroughly permeated with the oil. The quantity of the oil to be used should be determined by the use to which the timber is to be subjected.

"The Dead Oil of Coal Tar used by us in the treatment of timber contains carbolic and cressylic acids which were the only two substances out of the thirty-five examined by Dr. Calvert which perfectly prevented the growth of fungus life, while it is an established fact that timber impregnated with Dead Oil of Coal Tar offers perfect resistance to the ravages of the Toredo, the other insects, wet and dry rot.

"Dead Oil of Coal Tar is the only known material that effectually prevents the ravages of the marine worms and prevents decay."

EPPINGER & RUSSELL CO.,

First street and Newton Creek,
Long Island City, N. Y.

"THE GIUSSANI PROCESS."

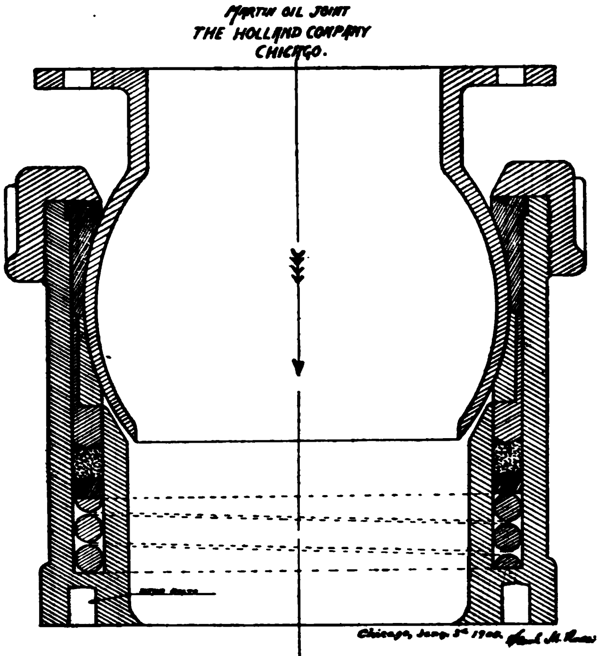
The process consists of submitting the tie to a hot bath of anthracene and pitch, heated to about 140° C. (284° F.) This anthracene and pitch having a high boiling point, shows no signs of ebullition at this degree of heat. Immediately upon the introduction of the tie into this hot oil, ebullition takes place and steam and moisture passes off, showing conclusively that some of the constituents of the wood are passing away. After a period varying from 2 to 4 hours, this ebullition ceases, showing that the sap and moisture have completely passed off.

After the above heating process, the tie is transported mechanically into a cold bath of heavy oil of tar; remaining in this bath for a period of about 10 minutes, again, it is mechanically carried into a bath of cold chloride of zinc, and remaining there a variable time, according to the amount desired to inject into the tie.

If it is so desired, the tie can be treated with oil of tar alone. In fact, anything in a preservative line can be so injected into the ties.

A guarantee that Beech ties shall last as follows: About 75 p. c. must last 10 years, 25 p. c. 12 years, and 15 p. c. 15 years.

F. W. Drury, Secy.



The Martin Oil Joint is adopted in this case to give flexibility at three different points. First to allow the reach of the connection to be held by the tower in a nearly vertical position when not in use; to allow it to be lowered to connect with the pump on the vessel and to accommodate itself to the varying position of the vessel. The joint has a rotary motion on the perpendicular of its axis and also a limited movement from the axis. Three joints are here used.

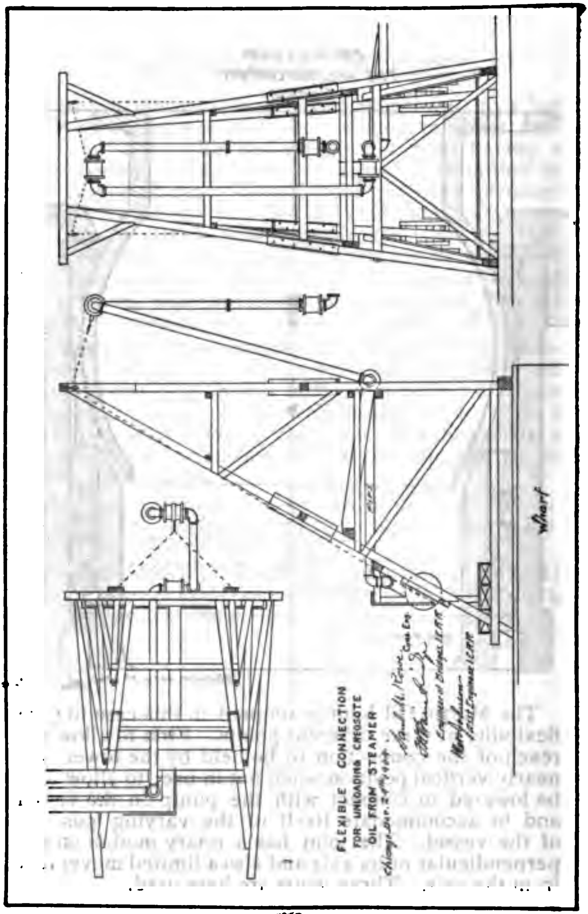
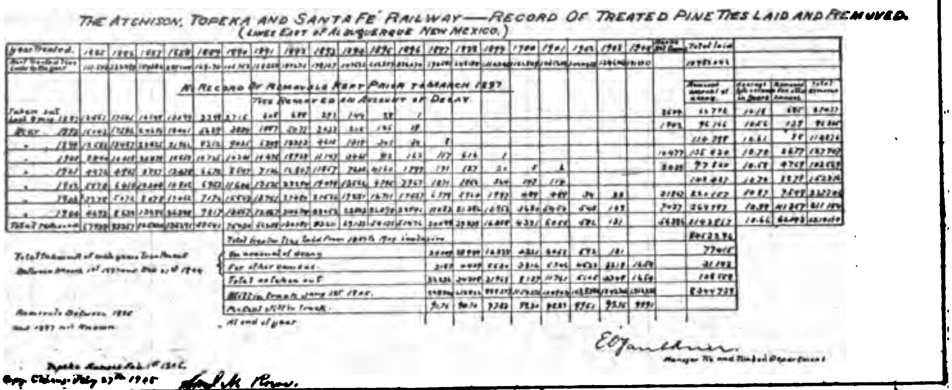

FLEXIBLE CONNECTION
FOR UNLOADING CREOSOTE
OIL FROM STEAMER
Wharf

Table "B" in lbs and Kilogrammes (= 2.2046 #)
Chihuahua & Pacific R.R. Timber Preserving Plant

Val. "S" .30			.35		.40		.45		.50		.55		.60		
"C."	lbs.#	Kilos.	#	K.	#	K.	#	K.	#	K.	#	K.	#	K.	"C"
1/4 %	243	110.0	217	98.3	182	82.7	162	73.5	146	66.1	133	60.1	122	55.1	1/4 %
1 1/2 "	1458	652.5	1250	566.9	1094	496.0	972	441.0	875	397.8	795	360.8	729	330.7	1 1/2 "
1 3/4 "	1701	771.7	1458	661.4	1280	580.6	1135	469.1	1021	417.6	927	420.5	851	385.8	1 3/4 "
2 "	1944	881.9	1667	755.9	1458	661.4	1296	587.9	1167	529.2	1051	481.0	972	440.9	2 "
2 1/4 "	2187	992.1	1875	850.4	1640	744.1	1458	661.4	1312	595.3	1193	541.2	1084	491.5	2 1/4 "
2 1/2 "	2480	1125.1	2083	944.9	1823	822.3	1620	744.1	1458	661.4	1336	601.3	1215	551.2	2 1/2 "
2 3/4 "	2673	1212.4	2291	1039.4	2005	909.4	1782	808.4	1604	727.5	1458	661.4	1337	608.4	2 3/4 "
3 "	2916	1322.9	2500	1133.8	2187	992.2	1944	881.9	1750	793.7	1591	721.5	1458	661.4	3 "
3 1/4 "	3159	1432.1	2708	1228.4	2369	1074.7	2106	955.4	1896	859.9	1723	781.2	1580	716.5	3 1/4 "
3 1/2 "	3402	1543.4	2916	1322.9	2552	1157.5	2268	1029.0	2041	926.0	1856	841.6	1701	771.7	3 1/2 "
3 3/4 "	3646	1653.5	3125	1417.3	2734	1240.2	2430	1102.4	2187	992.1	1988	901.9	1823	826.8	3 3/4 "
4 "	3889	1763.1	3333	1511.8	2916	1322.9	2592	1175.8	2333	1058.3	2121	962.1	1944	881.9	4 "
4 1/4 "	4132	1874.1	3545	1608.2	3099	1401.0	2755	1249.4	2479	1124.4	2254	1022.2	2066	937.0	4 1/4 "
4 1/2 "	4375	1984.3	3750	1700.9	3284	1489.1	2916	1322.7	2625	1190.6	2386	1082.3	2187	992.1	4 1/2 "
4 3/4 "	4618	2094.5	3958	1795.4	3463	1570.9	3075	1395.0	2771	1256.7	2519	1142.4	2309	1046.8	4 3/4 "
5 "	4861	2206.7	4166	1889.8	3646	1653.5	3240	1469.8	2916	1322.9	2651	1202.5	2430	1102.4	5 "
"t"	79.4		83.1		87.2		91.7		96.3		101.3		107.3		"t"
Kilo.		36.02		37.7		39.5		41.6		43.7		46.0		48.7	Kilo.

Chicago. Dec. 27th 1904. [illegible]

TABLE B. Pounds "avoirdupois" with equivalent in kilogrammes.


THE ATCHISON, TOPEKA AND SANTA FE RAILWAY—RECORD OF TREATED PINE TIES LAID AND REMOVED.
(LINES EAST OF ALBUQUERQUE NEW MEXICO.)

Year Treated.	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904		Total laid

A RECORD OF REMOVALS KEPT PRIOR TO MARCH 1897

TIES REMOVED ON ACCOUNT OF DECAY.

Taken out
Total removed
Total ties laid from 1885 to 1904 inclusive
On account of decay
For other causes
Total as taken out
Still in track
Percent still in track
At end of year

Removals between 1885 and 1897 not known.

Topeka Kansas Feb. 1st 1905.

E. O. Faulkner.
Manager Tie and Timber Department

Record of treated ties laid and removed A., T. & S. F. Ry., 1904.

SPECIFICATIONS FOR THE TREATMENT OF TIMBER.

INTRODUCTORY NOTE.

From the nature of the business and the varying conditions, few ironclad provisions can be fixed. So many matters are the subject of judgment derived from extended experience and the varying character of timbers in the various sections of our country that, aside from a few plain rules, suggestions only can be dealt with.

Then, again, only those processes that have been found effective by the test of time, and this sufficiently extended to give results sufficiently definite to satisfy the business public.

When the following have been named the field seems to be covered, at least to date, to-wit:

The Burnett or Zinc-Chloride process.

The Wellhouse or Zinc-Tannin process.

The Creosote process.

And probably the Zinc-Creosote or Rutger process.

Those processes above noted are treated as practiced twenty years ago, and such modifications as have been suggested by subsequent experience will be noticed in appended notes.

With regard to the CREOSOTE process, the cost of the oil has heretofore, and is still, a bar to its general use for the treatment of railroad ties within the scope of economy. To overcome this two processes are being exploited by which a fair penetration is secured by a much restricted use of the oil, with the view to getting a fair treatment at a much reduced cost. The Rueping process seeks this end by compressing the air in the timber, and with an increased pressure forcing the oil into the timber so as to permeate it, and then allowing the compressed air to force out a considerable portion, leaving what is claimed to be a sufficiency. The second, that of the Giussani, seeks the same end only by a different means.

The question whether this reduced amount will give as good or better result than the chloride is only

to be determined by trial on the ground and in the track. The probabilities are such in each case that it is well to notice the matter in this connection.

SPECIFICATIONS FOR BURNETTIZING.

PROCESS.—This process consists of impregnation of timber with a diluted solution of Chloride of Zinc.

METHOD OF APPLICATION.—This is done by introducing the timber into a hermetically closed retort, and the impregnation is induced by steaming, drawing a vacuum, and is expedited by pressure.

STRENGTH OF SOLUTION.—The strength of the zinc-chloride solution must be such that is found necessary to secure the prescribed amount per cubic foot of timber, this amount having been determined by careful test of the timber being treated.

ZINC-CHLORIDE, HOW MADE.—The zinc-chloride is made by combining zinc spelter with hydrochloric acid in such proportions as will combine perfectly, leaving no free acid. The fused chloride now manufactured or a concentrated solution can be used, both of which are being used.

QUANTITY REQUIRED.—The quantity of chloride required per cubic foot should be approximately one-half pound per cubic foot of timber.

PURITY.—The zinc chloride, if made from good zinc spelter, will be measurably pure. If fused should contain not over 6 per cent of all impurities and not over one-half of 1 per cent of iron.

METHOD OF IMPREGNATION.—The material to be impregnated is loaded on tram cars or buggies and run into a retort and subjected to:

1. Steam (saturated and not superheated) filling the retort and held until the timber is heated completely through to the boiling point under a steam pressure of not exceeding 20 pounds per square inch, for not less than such time as is found necessary to bring the timber to such temperature as above stated.

2. A vacuum shall be drawn on the charge to 26 inches if at or near sea level; for 3,500 feet elevation,

not less than 23 inches, and for 7,000 feet, not less than 20 inches of vacuum—said vacuum to be held not less than one-half hour after such degree of vacuum shall have been secured.

3. Without releasing the vacuum the chloride solution is let in to the retort, and when the retort is filled pressure shall be applied by means of a force pump until a pressure of one hundred pounds is attained, and so held until the desired impregnation is secured. The retort is then opened and the charge removed.

SPECIFICATIONS FOR THE WELLHOUSE OR ZINC-TANNIN PROCESS.

PROCESS.—The Wellhouse or Zinc-Tannin process consists in impregnation of the timber with the chloride of zinc solution, essentially as in the Burnett process, with a prescribed amount of dissolved glue added, followed by an application of tannic acid in solution, by which the glue, absorbed with the chloride, is neutralized and changed into a "leatheroid," the two serving to some degree as a plug in the pores of the timber and as a deterrent to the passage of water into or from the timber.

GLUE—Ordinary glue of commerce is used, that highest in Gelatine being preferable. Such glue as will combine with about an equal amount of tannin extract should be selected.

TANNIC ACID.—The extract of hemlock bark is usually employed, although there seems to be no reason why other tannin extracts should not be equally efficient. The tannin extract containing from 25 to 30 per cent of pure tannic acid is used, but if lower in the acid, more of the extract can be used.

AMOUNT OF EACH.—The glue and tannin to be used should, in the first place, be proportioned so as to combine completely, increasing that less strong in the essential qualities in larger proportion, each being made into a solution by adding pure water, the glue being added to the chloride solution and

applied with it, and the tannic solution being applied after the former solution is forced back. The amount of the glue and tannin should be not less than one-tenth of the amount of pure chloride used (each).

STRENGTH OF SOLUTIONS.—The strength of the chloride of zinc solution should be such that is found necessary to secure the absorption of the prescribed amount of pure chloride per cubic foot of timber, this amount having been determined by careful test of the timber being treated.

The amount of glue should be not less than one-half of 1 per cent in weight of the whole amount of chloride solution to which it is added.

The strength of the tannin soltuion should be one-half of 1 per cent in weight of the whole contents holding the tannin solution.

TO MAINTAIN STRENGTH OF.—Glue, unlike the chloride solution, is depleted by contact with the charge, hence should be reinforced after each exposure, and with the tannic acid it is the same; hence each should be renewed according to the following rule: "To the amount of tannin solution absorbed add the amount of the chloride solution absorbed, and for glue and tannin add one-half of 1 per cent by weight each to its proper receptacle, preparatory to the next charge of timber.

PROGRAM OF OPERATION.—The Wellhouse process consists of:

1. The application of saturated steam under 20 pounds per inch pressure until the timber has been heated to the boiling point to the center, for such length of time as is necessary to bring the heat of the timber to not less than 198 degrees Fah.

2. The steam being released, a vacuum is produced to 26 inches at or near sea level, 23 inches at an elevation of 3,500 feet, and 20 inches at 7,000 feet above sea level, all as indicated by mercurial gauge, and this held for not less than 30 minutes.

3. The vacuum being still held, the chloride, carrying also the glue in solution, is introduced, completely submerging the timber charge, and when the

retort is full, pressure is applied by means of a force pump until 100 pounds per square inch is attained, and so held until the desired or prescribed amount of impregnation is secured.

When the chloride solution is forced back into its proper receptacle, the tannin solution is introduced and pressure brought to bear to a maximum of 100 bs. per square inch and so held for about one hour and then forced back.

This completes the operation and the charge is withdrawn.

APPENDIX.

NOTE (A)—*Heating Solution.*—Originally in the Wellhouse process no special heating appliances were used. During the steaming process the chloride solution was heated to about 100 degrees Fah. and maintained something like this temperature under moderate climatic conditions. Subsequent experience, however, indicates that all stages of the treatment are facilitated by heating the solutions before or during application to the timber.

A still further and weightier reason is that the combination of the chemicals are much more complete. The appliances should therefore be adequate to raise the temperature to 140 degrees Fah. in the tubs, this being as hot as can be pumped, and then by means of heating coil in the retort the temperature should be increased 40 degrees more, or to almost boiling point.

NOTE (B).—Another modification of the Wellhouse, or rather of the zinc-tannin process, has been recommended and to some extent adopted, may be here noted.

THE THREE MOVEMENT.—Wherein the glue is made into a separate solution and applied after the timber has been impregnated with the chloride of zinc, and then followed by the tannin solution. Where timbers are very difficult to impregnate a larger amount of the chloride may be absorbed than

with the glue added, or at least such is the basis of this modification of the process.

NOTE (C).—Another modification of the above mentioned process is suggested by experience, *i. e.*, that of drawing a slight vacuum on finishing the impregnation with the chloride solution, withdrawing a portion of the chloride from the outside of the timber, where it is superabundant, thus allowing a greater penetration by the succeeding application, whether it be glue or the tannin, as in the first described Wellhouse process.

The same will apply to the Burnett process, where complaints have been made of much waste from the drippings after removal of the charge from the retort.

NOTE (D).—As before noticed, the action of the chemicals is found to be much accelerated by having the solutions hot, then with the same heating coils in action, after forcing back the solution and completion of the operation, why not allow the action to continue, thus rapidly drying the timber by vaporization, which does not affect or withdraw the chemicals, while it does withdraw the water rapidly.

It is well that this be tested, as the drying to any extent, small or great, tells in the after handling of the timber.

We discovered this fact in our small laboratory plant.

NOTE (E).—Another modification of the Burnett process is that of first boiling the charge in the oil without pressure for such time as will extract all the saps or moisture from the timber, then drawing out a portion of the oil by the vacuum pump and then introducing the zinc-chloride and putting it under the usual pressure of 100 pounds per square inch. This method of preparing the timber (seasoning) instead of using steam seems to commend itself. See post., pp. (223) Beal on Saturated Steam.

SPECIFICATIONS FOR CREOSOTING.

PROCESS.—The creosote process is understood to be the impregnation of timber by the use of the heavy extracts of coal tar, which in turn is a product of coal distillation in the manufacture of illuminating gas.

CREOSOTE consists of all the poisonous by-products of the coal distillation, and hence are destructive to all animal and vegetable life, and seems particularly adapted to the preservation of the wood and in no degree injurious to the wood fiber.

PREPARING FOR IMPREGNATION.—The timber is prepared for the reception of the creosote oil first by steaming the timber, as before described in Burnettizing and in the Wellhouse process, and following with the vacuum and introducing the oil while the vacuum is held.

PRESSURE.—As soon as the retort has been completely filled, pressure to not exceed 100 pounds per square inch is applied and held until the desired or prescribed amount has been absorbed.

HEAT OF OIL.—As the creosote oil hardens partially at a moderate temperature it must necessarily be heated, first in the receptacle in which it is stored, to a degree that will allow it to be pumped into the retort by the pressure pump by means of heating coils in the said storage receptacle, and then to a much higher degree after let into the retort by means of further and ample coils fixed in the retort.

CREOSOTE STORAGE TANK.—Owing to the volatility of the creosote oil and the tendency to waste, the tank or receptacle must be of metal. (Steel,) and be covered.

AMOUNT OF OIL REQUIRED.—In making specifications as to the amount of oil per cubic foot of timber to be required in treating, it is usual to require about as follows: For railroad cross-ties, 10 to 12 pounds; for dimension timbers, 15 to 20, and for piles, 20 to 30 or more per cubic foot of timber.

As timbers vary so much in density and absorbent powers, it would seem better and to be almost the

only practicable method to base the requirement upon this quality of the timber and let it be determined by actual trial. It is well known that the oil, especially the heavier and more valuable portion, cannot be forced into the timber to the extent that is possible with the aqueous solutions without undue pressure that will injure the timber and result, after the pressure is removed, in a great waste of the oil.

CREOSOTING.

NOTE (A).—Another method of impregnating with creosote oil is that of boiling the timber in the retort without pressure until the impregnation is complete. This is covered with patent.

NOTE (B).—Then, again, we have the Giussanni process, the creosote being contained in an unsealed vat of sufficient length (250 feet or more) supplied with heating coils, by which the oil is maintained at a high (boiling) temperature and the ties are loaded in sets of four or eight and carried through the vat at a very slow rate, allowing time enough to drive off all moisture, and finally the ties are plunged into a vat of cold oil for a few minutes and then discharged. In the process proper there is a tank of chloride of zinc solution, interposed between the hot immersion and the cold, the chloride solution being cold, by which the inner part of the tie is impregnated with the chloride. The whole process is carried through automatically from the time the sets of ties are clamped in until they are discharged with treatment completed.

NOTE (C).—"The Rueping process" consists simply in pressing the oil into the timber. It is operated on the principle that by the application of air pressure the air in the timber is reduced to one-half of its volume, then the oil is let in at that pressure, and then, by means of the force pump, the air is still further compressed, the oil forced into every part of the piece, then all pressure is released and the compressed air is allowed to force a part of the oil

out again, leaving the timber fiber coated, but retaining only about half of the oil.

NOTE (D).—When charge, having been treated by the ordinary process, comes from the retort, especially if it has been subjected to overpressure, it will be all of a drip with clinging and oozing oil. In such case it will be found practicable to clean the surface of oil and to save much of it by turning on live steam so as to fill the retort and hold for a few minutes. Not only is there a saving of oil, but the condition of the timber is much better for handling.

THE USE OF SATURATED STEAM.

The following address of Mr. F. D. Beal before the Wood Preservers' Association at New Orleans, January 18, is thought to be worthy of reproduction in this work. Mr. Beal is superintendent of the Southern Pacific Timber Treating Plant, West Oakland, Cal. We reproduce it by permission and commend the freedom with which the matter is treated. This shows that the association is proving very useful. S. M. R.

Of late years the demand for ties and structural timber has been so great for immediate use that manufacturers are unable to furnish a natural seasoned product. Therefore to a great extent it is necessary to season our material artificially in order to supply the demand placed upon us.

The question arises as to the best method of seasoning, also as to what constitutes the preliminary handling of timber to prepare it for the injection of the preservative fluid. A great deal of discussion is arising at the present time concerning the seasoning of timber, as to the best methods of carrying it out, etc.

Some maintain that all timber should be seasoned naturally, and not artificially, in order to secure the best results, which would mean only the evaporation of water contained in the wood. Others that, to insure perfect results, all wood acids and resinous

matters should be extracted, which would necessitate the artificial treatment to prepare it for the reception of the preservative liquid. Both sides are fortunate enough to be able to produce records covering the best of results in support of their arguments.

Characters and conditions of timber vary so greatly that one has to be governed by the immediate surrounding conditions and do the best under the circumstances. In the Burnettizing process, when green material is used for treatment, it is necessary to season artificially in order to prepare it for the injection of zinc solution. I found in my experience that the manner of seasoning had to be varied greatly, according to the character of the timber. On some classes of material I advocate air seasoning, on others I do not.

On the Pacific Coast we have a sap pine which we term "Shasta sap pine," running 75 to 90 per cent sap wood. On this class of material I think it would be policy to thoroughly air-season before treatment, as this class of material when green contains a large percentage of sap water and wood liquids, also a large percentage of resinous pitchy matter. By air seasoning a large amount of this liquid would be eliminated, which would shorten the process of treatment to a large extent.

But I think the process of seasoning should be carried further after the material has been placed in the cylinder, if for no other purpose than expelling the air in open cells, which would act as a resisting force against the injection of the preserving fluid. This, of course, can be accomplished by applying saturated steam, heating the timber thoroughly throughout, forcing all air out and any liquid matter remaining in the wood which would act as food for any destructive fungi, also killing all diseases peculiar to tree life.

As to safe temperatures, it would be pretty hard to set a standard that would be applicable to all classes of material. Some woods can stand a higher temperature than others without materially affecting

the strength of the fiber. Some classes of material which I have had occasion to handle I have carried as high as 280 degrees Fahr. without affecting the strength of the wood. On some classes of material this, possibly, would be pretty high.

On the Pacific Coast we have occasion to treat with the Burnettizing process a large amount of Oregon red fir ties, which you all know to be a firm, close-grained wood. On this class of material we obtain much better results by treating in the green state. In allowing these ties to air season the resinous matter becomes congealed and so hard that we find difficulty in dissolving this matter in order to allow our solution to penetrate readily. To do it the steaming has to be carried to such an extreme that, as a result, the material is practically burned up and worthless. We found that we obtained much better results by treating these ties green, steaming them from three to four hours, and not allowing the temperature to exceed 280 degrees Fahr., thus eliminating the resinous matter (which is to a certain extent in liquid form while the wood is green) much easier than if it had been allowed to harden by air seasoning.

I do not wish it to be understood that I believe in steaming timber as the best method of artificially seasoning it, but of course in the Burnettizing process, when zinc solution alone is used as a preservative, steaming is about the only way of applying our preliminary treatment. I believe that the process of using saturated steam as a means of seasoning timber, so universally carried out in this country, can be improved greatly by using other methods. Although good results are being obtained by using the steaming process, especiallv on the more open-grained, spongy woods, yet in treating the more denser woods, such as Oregon pine, red fir, etc., the steaming proposition has proven to be a complete failure when it is applied to large dimension timber and piling in the creosoting process. On account of having to be carried to such an extreme, in order to

thoroughly sterilize and remove the sap, moisture and other destructive matter in the wood, the strength of the material was so reduced that it was practically worthless.

There are a great many concerns using the steaming and vacuum process on these denser woods by using a limited amount of steam and then injecting the preservative. When applied in this manner good lasting results will never be obtained, for the moisture and destructive agents contained in the wood have not been removed, and the consequence is that the center of the material decays, leaving an outer shell of treated wood, the thickness of the depth to which creosote oil or other preservative liquid has penetrated.

It has been found by long experience in treating these denser woods that most perfect results are obtained by carrying on seasoning similar to Boulton's method of boiling the timber or piling in creosote oil, an improvement being made in the process by cutting out the operation of a vacuum pump and simply allowing the vapor to come off of its own accord, discharging into a surface condenser, through which cold water is circulated, thus creating its own vacuum by the elimination of sap and moisture contained in the timber.

In this manner, by carrying a low temperature, say 212 to 220 degrees Fahr., all the moisture can be extracted, the wood thoroughly sterilized throughout, and, one of the most important features of all, the exact dryness of the material can be ascertained by the amount of condensation collected in the hot well of the condenser, as all condensation collected represents moisture from the wood alone, and is not mixed with condensed steam, which would be the case when saturated steam was used in seasoning.

Seasoning timber in this manner has proven to be the most satisfactory method in existence, on account of its being applicable to any class of material with the best results, which cannot be said of saturated or superheated steam directly applied. It is the

most effective way of applying the heat, and you can accomplish the result with low temperatures, thus eliminating the possibility of injuring the wood fiber in any way by subjecting it to intense heat, which would be necessary were the seasoning carried out by steaming.

The length of time required is no greater than when treating with a steaming process, and on some classes of material the time of treatment runs considerably less. There is one important feature in connection with seasoning timber in the above manner; in instances when close-grained, firm, hard woods are what we term "water seasoned"—that is, the natural sap and moisture has been displaced by water absorbed on account of piling lying in the water in rafts for a long period. Ordinarily it takes a long time to extract this water, especially when piles run in large diameters. I have treated some of this class of material when the time of extracting the water alone was 75 hours on a single charge. After remaining in this condition for so long a time, one would naturally suppose that the life would be taken completely out of the wood, but quite to the contrary is the case. The piles come out in perfect condition, with hardly a sign of checking or cracking in any manner, and with nearly as much life and elasticity in the wood before treatment.

I firmly believe that instead of steaming our pine ties to season them we should give them a bath in creosote oil, maintaining the temperature above the boiling point of water for the length of time necessary to extract the sap and other injurious ingredients, and then inject our zinc solution, we would have a far superior product, besides having an oily coating on the exterior of the tie to turn the moisture and prevent to a certain extent the leaching of soluble salts.

AS TO PROCESS AND AGENTS.*

Perhaps one of the most important questions to be considered is the process you will decide to use. The whole trend of opinion seems now to be that only creosote or some modification of that agent, combined with other known preservatives, can be considered. With this view I concur as to effectiveness, but it must always be held in mind that to the extent that creosote is used there has to be the added cost of the creosote at the rate of three-quarters of a cent per pound, or nearly this over and above any mineral salt that may be used in combination with the oil.

For a tie impregnation with 12 pounds of oil, 9 cents per cubic foot, or 27 cents per average cross-tie, is added to the other items of cost. Were this alone to be considered, 35 cents instead of 12 cents (cost of zinc-tannin), it might be borne, but it is only inferior timber that will take this much without applying UNDUE PRESSURE which INJURES the texture of the wood, in which case the excess of oil will flow out again and be wasted, although technically the prescribed amount has been injected. Then, again, this same timber is scarcely ever penetrated throughout half of its volume, it being impossible, for well-established physical reasons, to penetrate the piece to the center, unless it be the very poorest and most porous timber (say Loblolly pine) over dried. Good, well grown timber of the better grade will not take 15 pounds to the cubic foot except by OVER-PRESSURE.

Some process that combines the oil with the more easily injected chloride of zinc, the oil acting afterward to protect the zinc, would seem to be in the direction of a better result than with the zinc chloride alone.

Among all the suggestions that of Mr. Beal, manager of the Southern Railway Timber Treating

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*Extract from report, August, 1905.

plant, seems to be the most feasible—namely, to boil the timber in the creosote oil until the water (moisture) is expelled, then fill it with chloride of zinc. This method has not, so far as I know, been tested for a series of years, yet it is in line of common sense and is worthy of trial. Much more so than most of the new processes now being forced into public notice in advance of the TEST OF TIME.

The penetration is slight, but it has the advantage of small expense of the oil, and as a more or less retarder of the absorption of water and a protection of the chloride of zinc, which will easily penetrate the coating of oil and fill the whole area of the piece.

The Rutger or zinc-creosote process is quite well authenticated and may well be used in the treatment of both ties and timber.

The process known as the "Allcrdyce," in which the timber is subjective to the zinc-chloride first and then subjected to the oil under pressure, I do not think can be of much value, as very little oil can be forced in, and that only the lightest and least valuable portion of the oil.

Several other processes are being promoted industrially, among which the "Rueping" and the "'Giussani," the latter an old one revised. If (as seems well authenticated) the high pressure used injures the fiber and solidity of the wood, then there is one insuperable objection to it, as from 220 to 230 pounds of pressure is used in the Rueping process. (See note page 233.)

In the practice of impregnating with chloride after steaming and the vacuum, as with the Burnett, zinc-tannin or the plain creosote oil, the rule has been well established that 100 pounds, or even less, will impregnate as well and as completely as a higher pressure, while a much higher pressure will separate the fiber and check the timber.

Let us look at the matter from another standpoint. If we subject any timber to immersion in clean water, we find that the water is absorbed first quite rapidly, and then more slowly. The very open

wood, when well dried before immersion, will cease to take any at the end of about sixty days and will not exceed 55 per cent of the volume of the timber, and the more compact will take less, until the most compact will take but 15 to 20 per cent; the mean of some fifty different specimens will be less than 30 per cent. When fully impregnated by natural capillary absorption, all the voids are presumed to have been filled and have become water-logged.

In creosoting sound piles or timber only about one-half of the volume is reached, and the voids of one-half of each cubic foot would not be more than 15 per cent, or 259.2 cubic inches, while 15 pounds of creosote would be about equal to two gallons or some 460 cubic inches, or 44 per cent greater than the voids in the timber. Anything in excess of this will be injected by over pressure and will gradually ooze out and be lost.

In the matter of treating piling there is no question that the injection of creosote oil in the greatest practicable quantity is the true policy, but in doing so its absorption should be induced rather than forced, which if handled intelligently will be equally effective. An ironclad specification as to quantity, if made at all, should conform to good judgment, taking into consideration the above facts.

I have gone into this phase of the matter more fully in consequence of many misleading theories and statements that have been current tending to throw discredit on well attested results of the less costly and more economical methods of treatments.

COST OF VARIOUS PROCESSES.

Taking the actual cost of the zinc-tannin process at four of the standard works in the United States as a basis, we have for a 3 cubic foot tie:

Chemicals	7.81 cents
Labor	4.61 cents
Making total net cost.....	12.42 cents

For a 3¼ cubic foot, this is equal to 15.26 cents—$3.45 per M. B. M.

In like manner the Rueping process would be, with 5 pounds per cubic foot, at ¾ cents per pound for oil, for a 3 cubic foot tie, 15.85 cents, and for a 3¾ cubic foot tie, 19.78 cents—$4.40 per M. B. M.

The zinc creosote would be two or three cents more, as in addition to the 5 pounds of oil there would be about 1½ pounds of chloride.

For full creosote with 15 pounds of oil per cubic foot a 3 cubic foot tie would cost 38.36 cents, and the 3¾ cubic foot, 47.95 cents—$10.66 per M. B. M.

The Ruetger or zinc creosote has the advantage that the partial impregnation by the creosote is supplemented by the half-pound of chloride, which does completely permeate the timber. This is especially true with regard to dimension timber, such as bridge stringers and caps, and only less so with piles. I do not know what, if any, change there may be as royalty on the zinc-creosote process, but its records in the past and the character of the operation seem to demand that it be considered.

In conclusion I would earnestly advise that in installing works that it be made to cover each and all of the most tried methods, The zinc-tannin, the zinc-creosote, the Rueping and the straight creosote all require much the same layout, and when the latter is provided for, very slight additional cost will cover all the others.

TO THE WESTERN SOCIETY OF ENGINEERS.*

It has been a work requiring much attention on the part of the managers of the Santa Fe Company to get the record, so far as to actual results, as to the effect of chemical treatment of their cross-ties.

The records are not as complete as could be desired, but are so carefully kept, so far as kept at all, that we should not complain. These records are

*Report to W. S. C. E., Chicago, March 30, 1905.

perhaps of more value than most that have been kept, on account of the large number treated and the extended time covered. It is here undertaken to restore approximately the lapse of record of tie removals during the first twelve years, and the method it is thought can hardly be questioned. The result is conservative at least, and within the probabilities.

This statement is now offered for the purpose of showing in a concise form the facts in relation to results of the Wellhouse, or zinc-tannin, process for treatment of railroad cross-ties on the A., T. & S. F. R. R. The timber treated was the Rocky Mountain pine of Colorado, New Mexico and Arizona, with a slight sprinkling of pinon. The treatment was commenced in 1885 under the supervision of the writer. Reports were furnished by the courtesy of the various officers of the railroad company, from which these tables are compiled.

Unfortunately no records of removals were kept until 1897, twelve years after the treating was commenced. In compiling the accompanying tables the probable removals are sought to be estimated by using the overage removals for the subsequent years. For instance, the diagonal for the first year, "d" to "c," added together and divided by the number of years gives the average of the eight years from 1897 to 1904, inclusive, giving one-hundredth of 1 per cent, the second year four-hundredths, the third year one-tenth of 1 per cent, and so on, so that in the fifth year only one and two-tenths per cent have been removed. This is less than are destroyed by accident outside of that of decay. It is then fair to say that practically none fail until the sixth year. The same class of ties untreated were exhausted to nearly 75 per cent in the sixth year, many failing at third year. Tables 1 and 2 are approximately correct, being compiled from, in some cases, fragmentary but still full enough reports to give a sufficiently close approximation for all practical purposes. Through President E. P. Ripley, General Manager

H. U. Mudge and Timber Agent E. O. Faulkner the annual reports have been furnished, so that most of the data is correct. Table 1 gives the percentage and table 2 the number of ties. This rate per year, as deduced from the later eight years, proves too high in the case of the 1885 ties by about 25 per cent, as those treated in that year sufficiently exhaust the number treated. To determine this quite definitely the percentage and the number also for the unreported years are correspondingly reduced. With subsequent years this reduction can only be done when they also approach exhaustion.

The present condition, however, enables us to further judge as to the probable mean life of those treated ties.

As none of the treated ties come out before the sixth year, we will take the ties treated in 1885 and 1899, inclusive, numbering 4,567,588, rejecting all those treated subsequently; 1,283,552 have been removed. That is less than 30 per cent at mean life of nine years. Of the 11,091,774 ties treated up to and including 1904, less than 12 per cent were removed. No reflections are intended, but in justice to the railroad company and to the Wellhouse process due credit should be given. A limited number of these ties were treated by the Burnett process in 1890, 1891 and 1892, but not enough to furnish definite data to make a comparison between that and the zinc-tannin. Perhaps when these approach exhaustion this may be done.

Since the matter of page 229 in relation to the Rueping process as to the pressure required to inpregnate the timber, the Author has been able to investigate the operation and finds that most of the softer timbers are successfully impregnated with a maximum pressure of not to exceed one hundred and thirty pounds. Hence this process can be carried out in any of the plants now operating on the Burnett or the zinc tannin processes.

TIMBER PRESERVATION. WELLHOUSE PROCESS. (ZINC-TANNIN.) OPERATIONS FROM 1885 TO 1900 (1.)

	YEAR.	No. Mos.	TOTAL CU. FEET.	EQUAL AV. TIE 4 CU. FT.	LBS. CHL.	MEAN COST PR. TIE	$	Lbs. TAN EXT.	MEAN COST PR. LB.	$	LBS. GLUE	MEAN COST PR. LB.	$	COST $ COST CHEM.	$ FUEL.	LABOR.	$ TOTAL COST.	TOTAL COST. CU. FT.	TOTAL COST. PR. TIE. CTS.
W.	1885	6 Mos.	485,929	121,837	1,231,363 lbs	.0678	9213.98	48,577	3.375	1649.52	50,057		2085.62	13044.12	752.84	6768.34	18915.62	.0394	16.095
	1886	11 "	1,338,348	287,084			14935.24	96061	3.30	3169.67	78472	.045	3621.66	21843.87	1288.78	11846.54	31035.11	.0330	13.790
	1887	8 "	843,763	214,577			12845.85	102,324	2.59	2965.99	90795		5260.73	20871.77	920.57	10,327.57	32119.91	.0394	15.745
	1888	8 "	1,249,402	311,883			20091.56	168,864	2.45	4111.63	147363		7468.37	32171.56	1614.98	13448.33	47134.72	.0375	16.080
	1889	7 "	850,601	212,644			12532.84	91671	2.63	2410.53	764.84		3682.38	18647.75	1019.47	999.065	29659.26	.0347	13.170
	1890	3 "	146,254	36,563			1555.06	12594	2.68	328.88	103.84		453.45	2340.88	121.10	3164.58	5615.96	.0376	15.289
X.	1890	4 "	304,215	75,653	(171465)		3108.95							3108.95	247.30	3758.23	9801.40	.0322	12.840
	1891	6 "	503,455	125,313	76,873		8545.65							8545.85	465.38	7451.29	16462.46	.0346	13.960
	1892	2 "	114,546	28137	30 603	2.63	2002.45							2002.45	127.20	1941.10	4070.75	.0364	14.140
Y.	1892	6 "	665,355	166,840	178,000	5.82	10304.99	73676	2.50	1841.90	63956	.0595	3805.38	16002.27	809.89	9441.09	26252.25	.0398	15.400
	1893	6 "	826,656	206,673	214,420	4.81	10320.37	68687	2.20	1507.16	60647		3598.16	15426.08	381.54	9137.00	24143.72	.0316	13.670
	1894	6 "	816,494	204,099	242,223	3.53	9257.88	68687	2.66	1825.04	68348		3866.78	14979.70	88.06	8605.81	20568.52	.0296	11.660
	1895	9 "	1162,546	291,932	480,246	3.60	16252.07	99627	2.18	2177.84	1063.44		4363.44	21973.35	724.43	11782.77	34289.15	.0296	11.970
	1896	5 "	1039,003	269,751	381,308	3.67	14007.89	100848	2.100	2107.64	96834		3964.55	20080.08	1075.86	7364.65	28759.07	.0276	11.060
	1897	1 "	148,484	37181	57,458	3.50	2150.65	14697	2.09	307.16	13447		637.33	3095.14	165.96	1242.47	4503.57	.0308	12.190
	1900	Aug.	288,771	72192	148,455	45%	6247.15	41587	2.24	931.54	31131	8¾	2478.80	9757.50	220.06	1,346.30	11323.89	.0393	15.540
	1891	Feb.	163,321	40,880	47,184	4¾c	1871.65	12923	2.42	312.75	8459	6¼	528.69	2713.07	187.53	1,481.01	4381.61	.0418	16.734
	"	Mar.	183,699	45925	46,133	4½c	1999.05	15921	2.42	385.28	11070	6¼c	691.87	3076.70	84.00	1940.23	5101.43	.0262	11.110
	"	Apr.	165,017	41254	57104	.0404	2307.58	14902	"	360.78	12953	"	745.08	3462.44	10.00	1,732.43	5205.87	.0315	12.620
Z.	1900	Sept.	266,736	66559	137618	.0425	5390.05	36684	2.24	821.83	25705	8¾c	2285.63	8497.51	207.05	1241.94	10446.87	.0392	15.654
	Y to Z.	Totals	5,462,533	1,442,776	1,934,156	.0412	79,719.73	542,514	2.318	12,573.86	501,639	.05385	27,015.70	119,564.37	5,962.38	52,216.60	178,574.35	.03326	13.365
	W to X.	& means	4,463,147	1,383,934	1,231,363	.0599	71,145.13	501,196	2.565	14,636.17	453,445	.04757	22,270.16	108,134.45	5717.79	55,045.46	165,545.65	.03693	15.021
	X to Y.	[illegible]	922,519	229,603	278,906	.0459	13467.35							13467.35	839.93	15150.64	30,384.61	.03440	13.647
	Totals &	means.	11,548,905	3,113,312	3,444,444	.0580	164,644.10	1,063,730	2.565	37,215.13	955,184	.05736	49,285.56	221,366.07	10,510.09	115,412.63	371,454.61	.03434	14.014

Chicago Nov. 20th 1900. Saml. M. Rowe C.E.

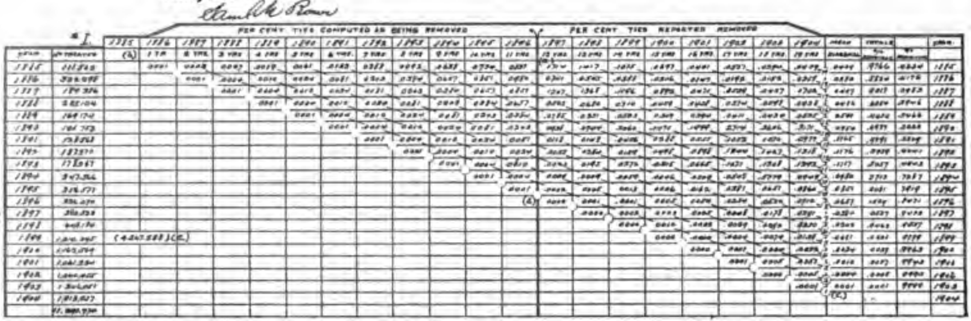
RECORD OF TIES TREATED ON THE A. T. & S. F. R. R.

	(FROM PARTIAL REPORTS.)													Chicago Nov. 28th 1900.	Paul M. Rowe C.E. (2.)
	YEAR.	No. MOS.	TOTAL COST per tie. CHEM.	FUEL.	LABOR.	STR. SOL. %	Absorption in sol.	lb. Z.C. cu. ft.	No. Ties. Pr. Run.	Cu. Ft. Pr. Run.	HCL. ACID, #	Metallic ZINC #	Process	MANAGER.	
W.	1885	6 mos.				.0150		.24814			341095	65887	WELLHOUSE.	S. M. R.	
	1886	11 "	.0788	.00482	.04965	.0160	.364	"	301	1360	409049	120376	"	" " "	
	1887	8 "	.1010	.00418	.05100	.0149	.336	"	267	1335	352965	115617	"	R. D. R.	
	1888	8 "	.1044	.00500	.04340	.0185	.387	"	295	1318	612400	177066	"	" " "	
	1889	7 "	.0873	.00510	.04910	.0150	.360	"	319	1336	371878	105811	"	" " "	
X.	1890	3 "	.0651	.00310	.05424	.0148	.298	.24814	325	1333	44618	13538	"	" " "	
	1890	4 "	.0470	.00370	.0790	.0148	.385	.30246	347	1257	158679	41468	BURNETT.	" " "	
	1891	6 "	.0677	.00484	.06630	.0150	.386	"	321	1239	184168	45176	"	" " "	
Y.	1892	2 "	.0702	.00480	.0675	.0154	.356	.30846	328	1288	14568	3671	"	G. W. N.	
	1892	6 "	.0878	.00600	.0649	.0151	.399		360	1339	2144	[illegible]	WELLHOUSE.	" " "	
	1893	6 "	.0684	.00150	.0548	.0161	.282	.2578	316		[illegible]		"	" " "	
	1894	6 "	.0738	.00054	.0440	.0178	.398	.2864	358	1368			"	" " "	
	1895	9 "	.0748	.00360	.0416	.0289	.512	.3766	368	1371			"	" " "	
	1896	5 "	.0779	.00480	.0376	.0219	.380	.3660	418	1310			"	" " "	
	1897	1 "	.0834	.00750	.0884	.0285	.315	.3378					"	" " "	
	1900	Aug.	.1352	.00300	.0186	.0246	.301	.5144					"	" " "	
	1898	Feb.	.1646	.00730	.05843			.4260					"	R. D. M.	Bellmont. (very green)
	"	Mar.	.0698	.00153	.04330			.3500					"	" " "	" "
	"	Apr.	.0840	.00030	.04457			.3460					"	" " "	" "
Z.	1900	Sept.	.1352	.00310	.01866	.0247		.5130					"	G. W. N.	Las Vegas.
	Y to Z.	Totals.	.0789	.00541	.04039	.0207	.3303	.37477	331	1357	2104		"		
	W to X.	[illegible]	.0767	.00448	.04881	.0147	.3190	.24714	301	1335	357415	399,398			
	X to Y.	[illegible]	.06163	.00393	.07090	.01506	.3793	.30846	332	1266	303/397	177,383			
	Totals & Means.		.0714	.00339	.05551	.01682	.3412	.30719	325	1308					

RECORD OF THIS TREATMENT ON THE A. T. & S. F. R. R. CONTINUED.

ANALYSIS OF RECORD OF TREATED TIES
A T & S F R R
1885 TO 1904

Chicago, Mar [illegible] 1905



This statement is now offered for the purpose of showing in a concise form the facts in relation to results of the [illegible] or Zinc [illegible] process for treatment of railroad cross ties on the A T & S F R R. The timber treated was the Rocky Mountain pine of Colorado, New Mexico and Arizona, with a slight sprinkling of [illegible]. The treatment was commenced in 1885 under the supervision of the writer. Results were furnished by the courtesy of the various officers of the railroad company from which the two-page table was compiled (See pp

Unfortunately no records of removals were kept until 1897, twelve years after the treating was commenced. In compiling the accompanying tables, the probable removals are sought to be estimated by using the average removals for the subsequent years. For instance, the diagonal for the first year "A" to "B" added together and divided by the number of

1

years gives the average of the eight years from 1897 to 1904 inclusive, giving one-hundredth of one percent, the second year 4/100ths, the third year 1/10th of one percent and so on, so that in the fifth year only 1-3/10ths percent have been removed. This is less than are destroyed by accident outside of that of decay. It is then fair to say that practically none fail until the sixth year. The same class of ties untreated were estimated to nearly 70 percent to the sixth year many failing at third year. Tables I and II are only approximately correct, being compiled from, in some cases, fragmentary, but still full enough reports to give a sufficiently close approximation for all practical purposes. Through President E P Ripley, General Manager H. U Mudge, Timber Agent E. O Faulkner, the annual reports have been furnished, so that much of the data is correct. Table I gives the percentage and II the number of ties. This rate per

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ANALYSIS OF RECORD OF TREATED TIES ON THE A. T. & S. F. R. R, 1885 TO 1900.
PER CENTS REMOVED ANNUALLY.

YEAR	NO. TREATED	1885 (A)	1886 1 YR.	1887 2 YRS.	1888 3 YRS.	1889 4 YRS.	1890 5 YRS.	1891 6 YRS.	1892 7 YRS.	1893 8 YRS.	1894 9 YRS.	1895 10 YRS.	1896 11 YRS.	1897 12 YRS.	1898 13 YRS.	1899 14 YRS.	1900 15 YRS.	1901 16 YRS.	1902 17 YRS.	1903 18 YRS.	1904 19 YRS.	MEAN REMOVAL	TOTAL REMOVED	IN SERVICE	YEAR
1885	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1885
1886	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1886
1887	[illegible]				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1887
1888	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1888
1889	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1889
1890	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1890
1891	[illegible]								[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1891
1892	[illegible]									[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1892
1893	[illegible]										[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1893
1894	[illegible]											[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1894
1895	[illegible]												[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1895
1896	[illegible]													(E) [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1896
1897	[illegible]															[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1897
1898	[illegible]																[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1898
1899	[illegible]	([illegible]) (E.)															[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1899
1900	[illegible]																	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1900
1901	[illegible]																		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1901
1902	[illegible]																			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1902
1903	[illegible]																				[illegible]	[illegible]	[illegible]	[illegible]	1903
1904	[illegible]																					(E)	[illegible]	[illegible]	1904
	[illegible]																						[illegible]	[illegible]	

year as deduced from the later eight years proves too high in the case of the 1885 ties by about [illegible]%, as these treated in that year sufficiently exhaust the number treated; to determine this quite definitely, the percentage and the number also for the unreported years are correspondingly reduced. With subsequent years this reduction can only be done when they also approach exhaustion.

The present condition however, enables us to further judge as to the probable mean life of these treated ties.

As none of the treated ties came out before the sixth year, we will take the ties treated in 1885 and 1889 inclusive, numbering 4,1[illegible], rejecting all those treated subsequently. 1,[illegible] have been removed; that is less than thirty percent at mean life of nine years. Of the 11,091,[illegible] ties treated up to and including 1904, less than [illegible]% were removed. No reflections are intended, but in justice to the railroad company and to the "Wellhouse" process, due credit should be given. A limited number of these ties were treated by the Burnett process in 1900, 1901 and 1902 but not enough to furnish definite data to make a comparison between that the Zinc-Tannin. Perhaps when these approach exhaustion, this may be done.

Chicago, March 20, 1905

Saml. M. Rowe, C.E.

ANALYSIS OF RECORD OF TREATED TIES ON THE A. T. & S. F. R. R., 1885 TO 1900. (NUMBER) REMOVED ANNUALLY.

THE ATCHISON, TOPEKA & SANTA FE RY. (WESTERN GRAND DIVISION)

STATEMENT OF TIES TAKEN OUT AND OF INSERTIONS. FIRST HALF OF YEAR 1905.

Western Division — Taken out

Year Treated	Treated: Rotten	Treated: Other causes	Treated: Total	Not Treated: Rotten	Not Treated: Other causes	Not Treated: Total	Total Taken out
1885	5		5				
1886	47		47				
1887	139		139				
1888	166		166				
1889	757		757				
1890	75		75				
1891	77		77				
1892	338		338				
1893	1474	13	1487				
1894	2,128		2,128				
1895	2,345	40	2,385				
1896	3,507	40	3,547				
1897	218	2	220				
1898	338	47	385				
1899	250	62	312				
1900	274	29	303				
1901	311	47	358				
1902	3	14	17				
1903		19	19				
1904		61	61				
1905							
[illegible]	275		275				
Total	12,316	374	12,690	71,197	1,748	72,945	85,635
Average Life	10.8 years.			Not known			

Colorado Division — Taken out

Year Treated	Treated: Rotten	Treated: Other causes	Treated: Total	Not Treated: Rotten	Not Treated: Other causes	Not Treated: Total	Total Taken out
1885							
1886							
1887							
1888	161		161				
1889	11		11				
1890	18		18				
1891	105		119				
1892	476	3	479				
1893	1,071		1,071				
1894	2,423		2,423				
1895	1,608	8	1,616				
1896	2,008	8	2,016				
1897	727	60	787				
1898	214	11	225				
1899	21	10	31				
1900	3		3				
1901		8	8				
1902		41	41				
1903	2	13	15				
1904							
1905							
[illegible]	64	66	130				
Total	9,122	179	9,301	17,615	584	18,199	27,400
Average Life	10.3 years			Not known			

New Mexico Division — Taken out

Year Treated	Treated: Rotten	Treated: Other causes	Treated: Total	Not Treated: Rotten	Not Treated: Other causes	Not Treated: Total	Total Taken out
1885	344		344				
1886	378		378				
1887	390	14	404				
1888	556	18	574				
1889	1324	5	1329				
1890	1465	6	1471				
1891	1990	16	2006				
1892	5791	72	5863				
1893	3,815	57	3,872				
1894	3,652	39	3,691				
1895	3,438	63	3,501				
1896	5,540	31	5,571				
1897	3,604	146	3,750				
1898	4,074	186	4,260				
1899	3,669	217	3,886				
1900	457	101	558				
1901	485	333	818				
1902	61	595	656				
1903	10	103	113				
1904		71	71				
1905		95	95				
[illegible]	897	133	1030				
Total	40,133	2,176	42,309	9,801	266	10,067	52,376
Average Life	10.8 years			Not known			

Rio Grande Division — Taken out

Year Treated	Treated: Rotten	Treated: Other causes	Treated: Total	Not Treated: Rotten	Not Treated: Other causes	Not Treated: Total	Total Taken out
1885	2,575		2,575				
1886	1,478		1,478				
1887	4,342		4,342				
1888	5,553		5,553				
1889	1,036		1,036				
1890	288	61	349				
1891	1,332		1,332				
1892	5,721	107	5,828				
1893	2,197		2,197				
1894	2,813		2,813				
1895	3,295		3,295				
1896	1,374		1,374				
1897	571		571				
1898	136		136				
1899	848		848				
1900	58		58				
1901	16	32	48				
1902		35	35				
1903		41	41				
1904							
1905							
[illegible]	672	470	1142				
Total	33,370	743	34,113	8,266	501	8,767	42,880
Average Life	15.1 Years			Not known			

A. T. & S. F. TIES REMOVED FIRST HALF OF 1905: (E. O. FALKNER)

SUMMARY OF THE TIMBER PRESERVATION AT THIS DATE. (1905.)

In this country, the treatment of railroad ties and timber only dates back twenty years with a few exception efforts in a tentative way and in but limited quantities.

The chloride of zinc and creosote (dead oil of coal tar), taking the lead as the agents, the former owing to the cost coming within the limit of economy has so far outstripped the use of the former that to-day scarcely one great railroad can be found using creosoted ties systematically. On the other hand, ten or twelve of the largest railroad systems are fast filling their tracks with treated ties almost to the exclusion of untreated. These railroads are using either the Burnett, the simple chloride of zinc process or a modification, in which glue and tannin are employed as a retardent to help to conserve and to prevent in some degree the waste of the chloride by leaching.

Mr. E. O. Faulkner, of the Santa Fe, estimates that up to last year, near 14,000,000 ties had been treated and placed in track in the United States up to and including 1904, which is probably a conservative estimate. While this is but a small proportion of all ties in use, only about two and one-third per cent, even if all the treated ties were still in, probably about one-third of these have been removed in the case of the earlier years.

The records are not as perfect and complete as could be desired but even in the face of imperfect records and with indications of imperfect treatment as a possible element, the zinc chloride has shown a great economy in the maintenance of the roadway.

The summing up will undoubtedly closely parallel the estimate given in Hausser of the Midi Railway in his report to the Seventh Session of the Railway Congress, summing up the results in France, to-wit:

"Although it is very difficult to give a rule at all generally applicable, it may however be said that there is a unanimous opinion that pickling materially

increases the life of sleepers; approximately the life is doubled in the case of oak sleepers, tripled in that of pine and quintupled (?) in that of beech."

The interrogation point is interpolated as the as to quintuple, for the beech may be too high for this country. We know that with the hard maple (sugar tree), that the sugary saps cause incipient decay to proceed rapidly from the moment the tree is cut and the same may be true of the beech.

Creosote, where full impregnation can be had, has almost invariably proved effective in prolonging life of the timber and in certain lines has been resorted to where prolonged life was very essential, notwithstanding the excessive cost.

Two new processes are being experimented upon recently to impregnate using less of the oil so as to bring the cost down to the line of economy.

The "Rueping" process does this by simple pressure, the timber to be well dried before treating. The "Giussani" process reaches much the same result by boiling in oil and suddenly cooling the timber by plunging into a cold oil or solution, trusting to natural laws to complete the impregnation. By either of these an impregnation to the amount of 4 to 5 lbs. of oil is forced in.

This of course will cheapen the treatment but only the lapse of considerable time will demonstrate the degree of success.

Whether it is wise to go largely into experiments of this kind is for each party interested to say for themselves.

The records of the chloride treatments has been scanned carefully in the last few years and thus far we have little reason to believe that we in this country are behind the old country either in method or in results.

The "Rutger" or zinc-creosote process seeks the same result with a small additional cost, that of the three to five pounds of the creosote oil. (Editor.)

Chicago, Oct. 12th, 1905.

CREOSOTE.

With reference to where and how creosote oil or dead oil of coal tar is produced, the following extract is taken from a report made to the 7th Engineering Congress held in Paris in 1900, by Mr. Hausser, Chief Engineer Permanent Way, of the French Sidi Railway, to-wit:

"In the case of Creosote, the specifications vary to a greater extent (than with the chloride or the cupric sulphate) as the substance itself varies, according to its origin.

Most organic substances, if ignited in the absence of air, give volatile hydrocarbons (acetylene, ethylene, etc.), benzine, etc., and finally liquid and solid hydrocarbons (naphthaline, anthracene, etc.)

When ordinary coal is distilled, the volatile hydrocarbons form coal gas, and the liquid and solid hydrocarbons go to the tar.

The tar on distillation gives hydrocarbons and the bodies containing oxygen. In the distillation two phases are to be distinguished.

At first, below 200 deg. C. (392 Fahr.), light oils distill over, they consist chiefly of hydrocarbons and of phenols.

Subsequently, between 200 and 300 C. (392 and 572 Fahr.), heavy oils come over; they contain phenols and are also rich in naphthaline (c 10 H. 8).

Phenols differ from naphthaline in containing oxygen. Generally speaking the phenols may be considered as alcohols capable of forming ethers with acids; but with sodium or potassium they form a carbolate.

It is true that the latter are not very stable, but this reaction shows that the phenols resemble acids. Hence phenol is sometimes called carbolic acid (C. 6 H. 5 OH)

Hence creosote is a mixture of light and heavy tar oils and in order that it may act as a preservative of timber it should consist chiefly of heavy oils.

What the relative value of phenols and its homologues and naphthaline are as preservative agents

TIMBER TREATING AND TESTING LABORATORY.

The establishment of a testing laboratory for the investigation of principles involved in the practical treating of timber by the Bureau of Forestry will meet another line of inquiry heretofore but imperfectly provided for.

Even among those most experienced in the matter it often occurs that differences arise in the interpretation of the nature of the physical agencies involved. It is important that each and every one of these should be carefully and systematically studied and that authorative conclusions be arrived at, the same as is done in other lines of inquiry. In addition to this, all agents for the chemical treatment of timber, both known and such as may hereafter be suggested from time to time should be treated in the same manner, carefully and exhaustively.

To enable this to be done, provisions should be made to cover every possible phase by the most perfect appliances and machinery with the widest scope of functions for experimental treating and for the study and analysis of the agents used.

The preservation of timber is one of the most important measures toward the conservation of the forests of this country as it applies directly to one of the heaviest drafts on the timber supply, that of cross-ties and bridge timber for railroads. Treated as here proposed, it certainly is a proper line of investigation by the department and must result in great benefit to all concerned and to the country, at large. Heretofore, in applying to chemists for aid in the study of the chemical agents, the lack of a thorough understanding of the methods of application, has been a distinct embarrassment. The treatment and study of the chemical agents should go together, the most intimate relations being maintained between the operator and the chemist so that each shall co-operate having a thorough understanding of both parts of the investigation.

The practical operator of the day, may be able to carry out the various functions accurately and with skill while he may know little of the nature of the chemicals; on the other hand the chemist cannot fully comprehend the relation of the chemical agent to the practical handling of the appliances during the process unless he understands the practical workings.

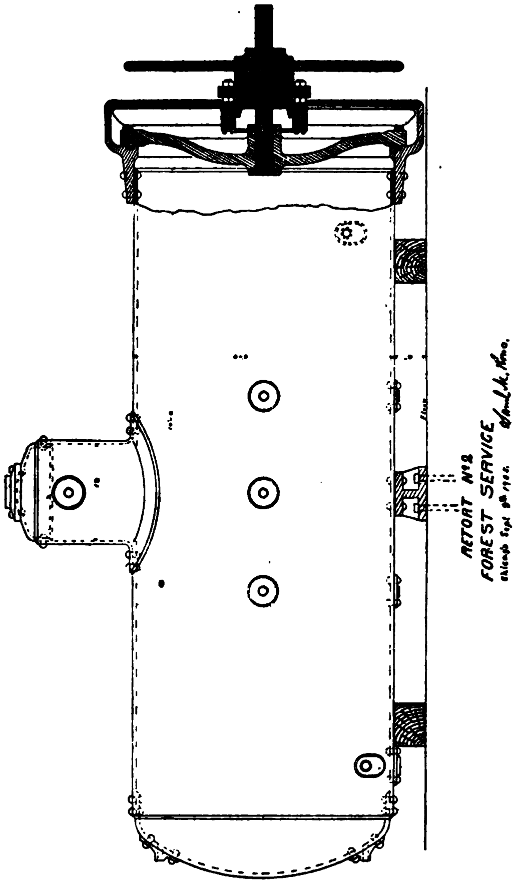
When, as here proposed, the two lines of inquiry are carried forward jointly, the result should be definitely valuable if followed by a systematic study of the result on the timber by subjecting it to the action of the elements, both in use on some convenient track under heavy traffic and under such forced tests as are practicable at the laboratory.

Intimately connected with this investigation is the matter of record of state of the treated timber from time to time during coming years, in which the progress of decay is noted.

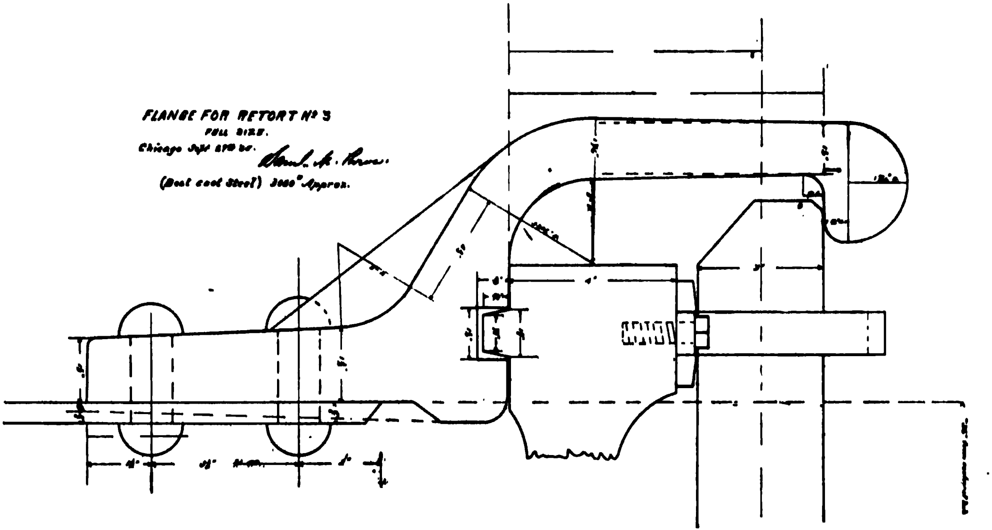
It would be of sufficient importance, too, in this connection to have untreated timber laid at the same time, as thus one important element in the inquiry would be determined, that of relative life by which the value of any treatment can be determined. There is little definite knowledge as to this at this time, authorities differing widely.

Chicago, Oct. 24th, 1905. (R.)

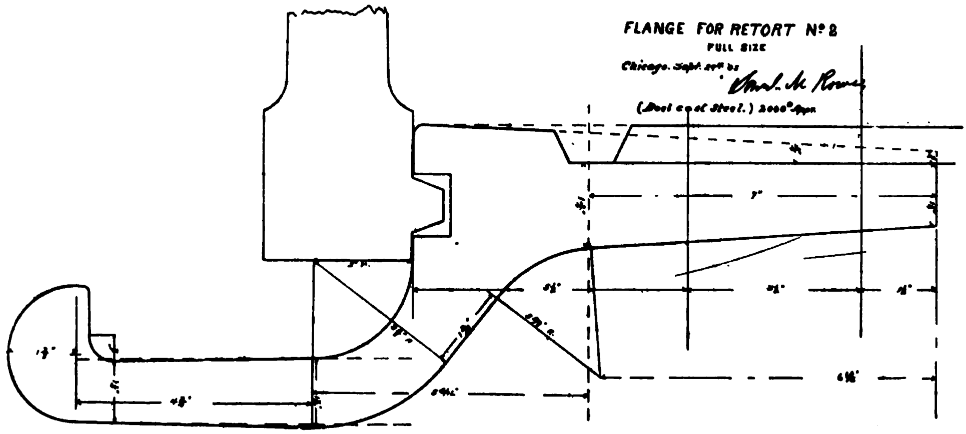
Some orignal studies relating to laboratory plant are here introduced so as to preserve this record.



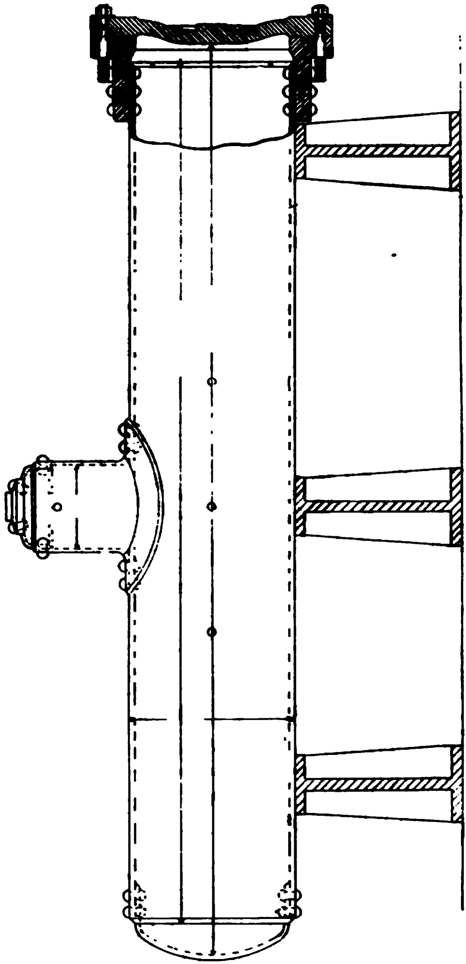
RETORT No. 2 STUDY.



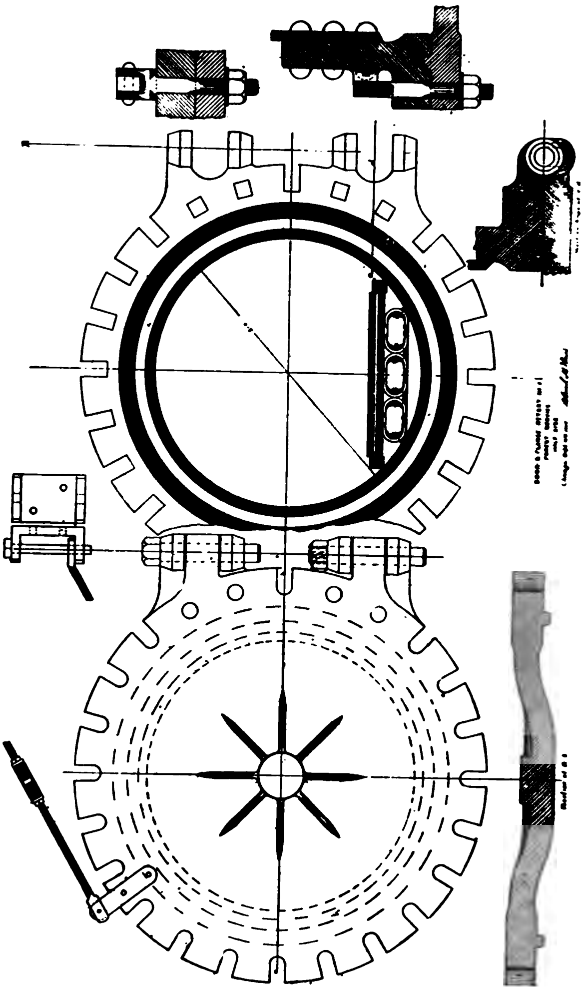
CAST STEEL FLANGE FOR RETORT NO. 2. (ORIGINAL.)



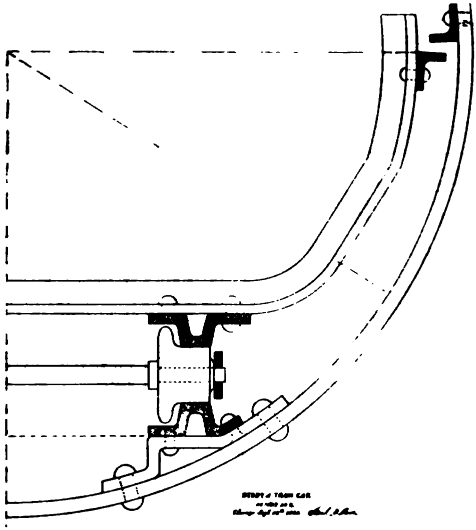
CAST STEEL FLANGE FOR RETORT.



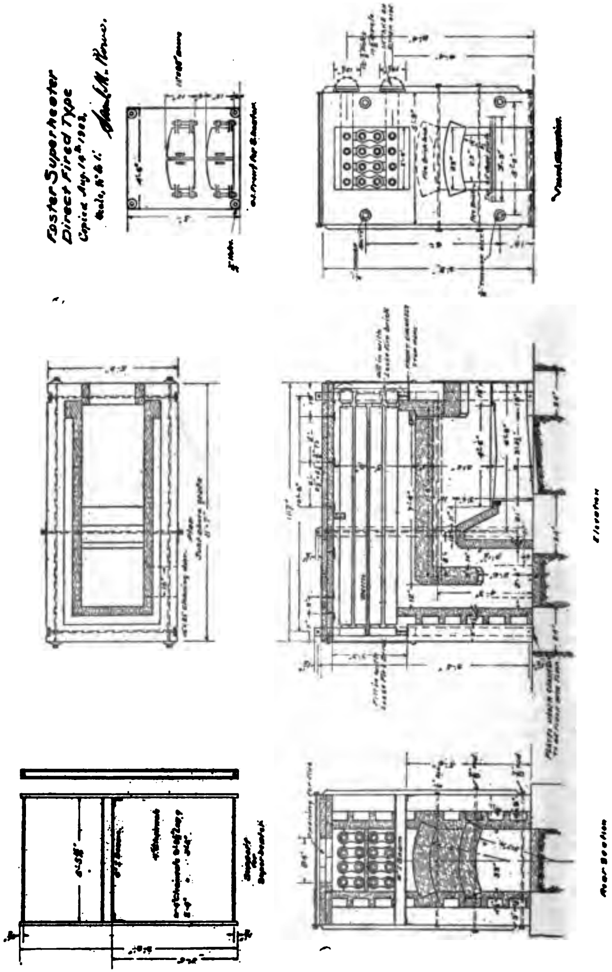
RETORT No. 1 STUDY.



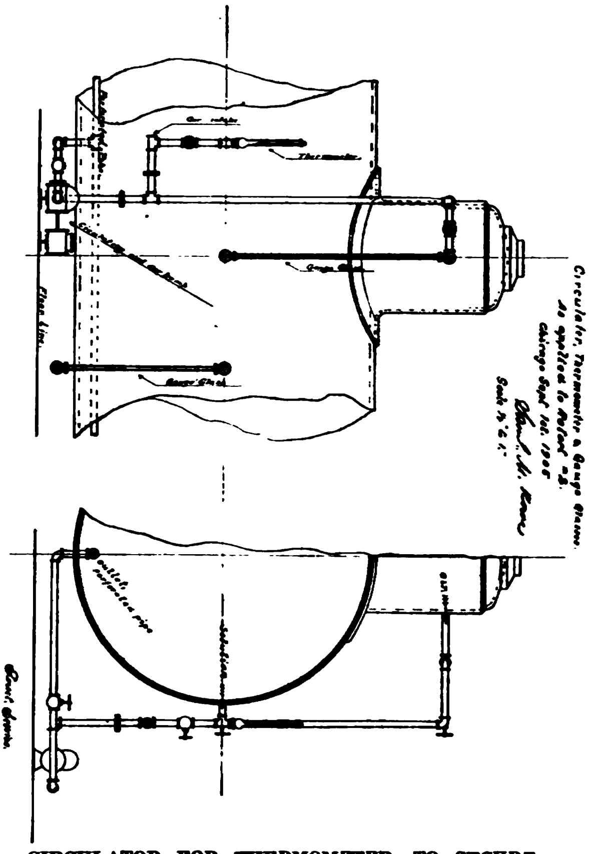
DOOR RETORT No. 1.



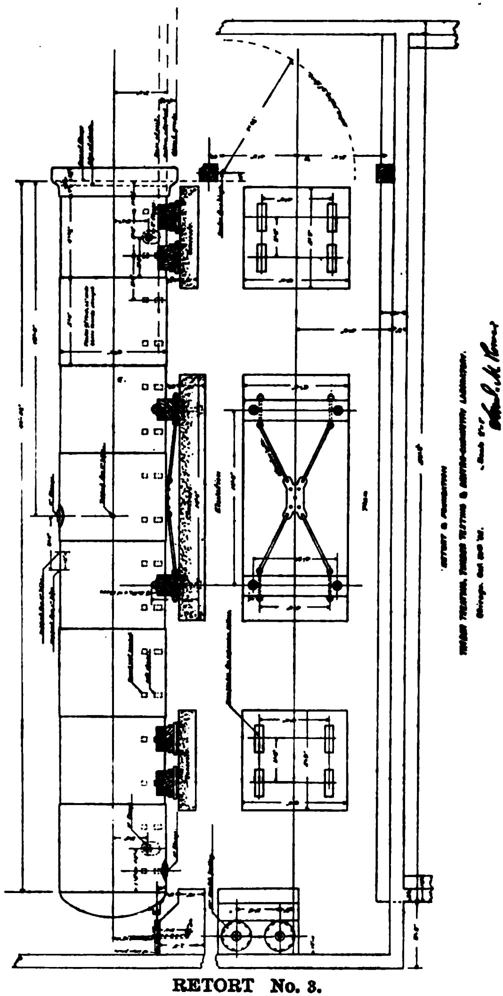
STUDY OF CAR FOR RETORT No. 2.



FOSTER SUPERSTRUCTURE.



CIRCULATOR FOR THERMOMETER, TO SECURE AVERAGE TEMPERATURE.



RETORT No. 3.

SPECIFICATIONS FOR THE TREATMENT OF TIMBER

On page 215 ante the author has called attention to the fact that owing to the wide range in the character of the timber desired to be treated, no special rule as to the quantity to be injected can be fixed upon. The common practice has been to fix the amount per tie or cubic foot of timber, where contracts are being made between a railroad company and a private company who contract to treat the ties.

The implication follows that when the contractor has put this much in, he has satisfied the specification. With the zinc-chloride it will be seen that a wide open door is left by which merely by raising the strength of the solution, the specified amount of the chemical can be secured while but a small part of the tie is impregnated. This also applies where creosote oil is used in connection with the chloride of zinc.

We have always kept it before our readers that "THE MATTER OF FIRST IMPORTANCE IS TO SECURE THOROUGH IMPREGNATION" the matter of quantity being of secondary importance.

In making contracts, this should be considered and guarded first of all both in the specifications and by rigid inspection by a competent inspector thoroughly competent and experienced and well paid; because such experience cannot be acquired except at the expense of much time and money on his part. This he can well afford as by attaining such skill as he should have, his value will be doubled. Thus it will be up to the contractor to do his work right, and not to be able to fall back upon a provision of the specifications that are faulty, as above shown.

It is a common practice when quantity is specified, to stop the process when the requirement is met,

and before the receptivity of the charge is exhausted, and the impregnation incomplete. This is radically wrong and shows such a specification to be faulty.

PILING AND SEASONING BEFORE TREATING, AND DRYING AFTER TREATING OF TIES.

Much has been written in relation to this matter largely based upon theory.

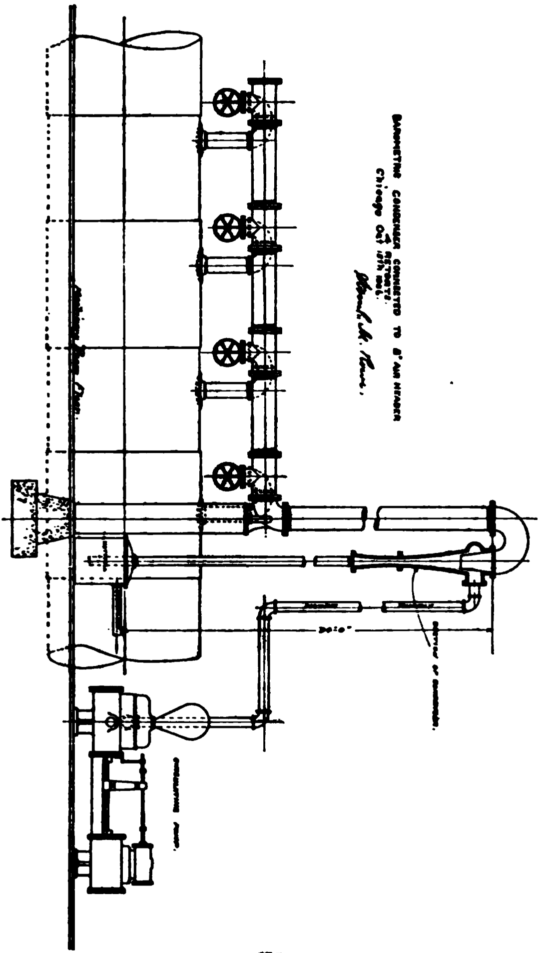
First; it is urged that the timber cannot be impregnated without seasoning, and then again that they cannot be put into track until dried again. Then again, it is claimed by the same authority that the ties should not be dried too quickly as the timber would check in consequence. What are we to believe?

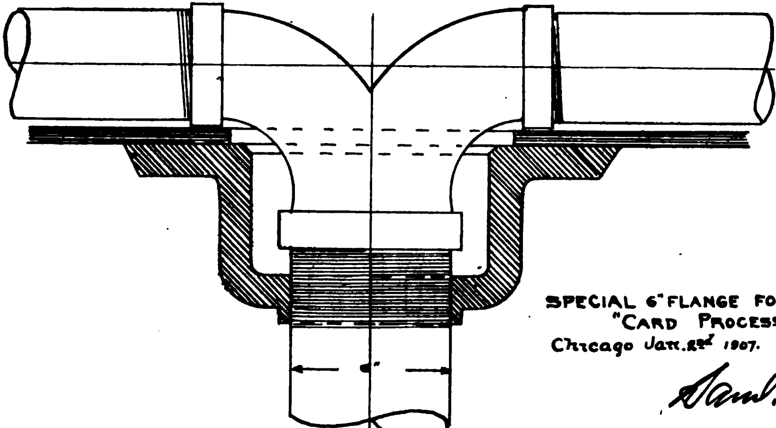
Query. Does not the checking take place largely during the air seasoning and not after treating and should not this be attended to before treating?

It is not proposed to enter into a controversy on these points but to say that by following these theories, large expense is incurred to no purpose.

With regard to this as well as many other questions, it is well to leave them to the manager of the works with freedom of judgment as the best guide, only specifying that the report as to conditions and reasons shall be truly reported.

If ties cannot be well dried as is often the case, they should be treated so as it can be known that they are well impregnated. The amount of creosote must be a matter as to what the timber will take after being properly prepared for impregnation, and if the ties will dry out quickly as they will, this too should be left to the judgment of the manager. There is no reason why treated ties will dry out as they often will, before they can be laid, should be carefully piled in the yard and again reloaded. All these matters are largely a matter of judgment with the operators, experience furnishing the guide.


BAROMETRIC CONDENSER CONNECTED TO 8" AIR HEADER
4 RETORTS.
SECTION OF CONDENSER.
CIRCULATING PUMP.
Machinery Room Floor.



SPECIAL 6" FLANGE FOR AGITATOR.
"CARD PROCESS"
Chicago Jan. 22d 1907.

Saml. M. Rowe.

SPECIAL 6" FLANGE SHOWING
DISCHARGE CONNECTION AT BOTTOM OF RETORT
1-ON EACH RETORT.

A treating Plant for any process may be designed and operated successfully, but it must conform to the following:

FUNDAMENTALS TO BE CONSIDERED IN PLANS

First. That the works should be proportioned throughout to secure the desired output.

2nd. That each part should be proportioned to do the desired work, still each proportioned to all the other parts so that there be no useless or surplus capacity or useless cost.

3rd. That each part perform its function in the most direct and in the simplest manner.

4th. That every part be of the best manufacture and the most reliable for lasting service so that repairs shall be infrequent, saving loss of time and expensive maintenance.

5th. That the working parts be so arranged as to be promptly operated with the least manual labor.

6th. That plans of all the essential parts be fully planned and prepared so that there be no extra labor or delay during erection.

7th. That the arrangement of the works be such that accurate measurements and weights shall be provided for so that it shall be possible to know what is being done, at any or all times.

8th. That the operator of the works shall be thoroughly competent, experienced, thoroughly honest and faithful, so as to be a safeguard between the two parties concerned.

In the practical part of the operation of timber impregnation entire good faith between the railroad Company and those who contract to treat their timber, is in all respects the best. If the specifications are right and the works properly arranged, the commercial instinct should cut no figure, as the work can be rushed to full capacity of the works without detriment or prejudice to either party.

The records of past treatment have been lowered by

"rush work" undoubtedly, whereas first class work would have been done at no additional cost.

Thorough and competent inspection is the only safeguard and will redound to the advantage of both parties.

It has been the principle of the author to hold to straight, honest work based upon correct principles and hereafter as heretofore to strike at every departure towards slack work or erroneous notions and this will be done without fear or favor.

COST OF A TIMBER PRESERVING PLANT

We are able here to give a fair approximate cost derived from past experience by accumulating the aggregate of cost of the various contracts with the manufacturers, the three retort being most often called for, at the same time the most economically operated and is here tabulated for the several processes, the figures given being deemed a safe net cost covering a possible advance in prices of metal and machinery, etc.

The first item in the table is net cash cost, the second, a conservative estimate of capacity to treat average railroad cross-ties of three cubic feet each, and the third item, the weight of machinery on which to compute cost of freight.

Process......	Burnett	Zinc-Tannin	Zinc-Creosote*	Rueping*	Creosote*
2 Retort Wks	$64,600.00	$56,600.00	$56,600.00	$64,250.00	$58,400.00
Capacity.....	4,200	8,000	4,200	5,000	4,200
Wt. Mach., etc...	707,800 lbs.	749,600 lbs.	749,600 lbs.	785,200 lbs.	707,800 lbs.

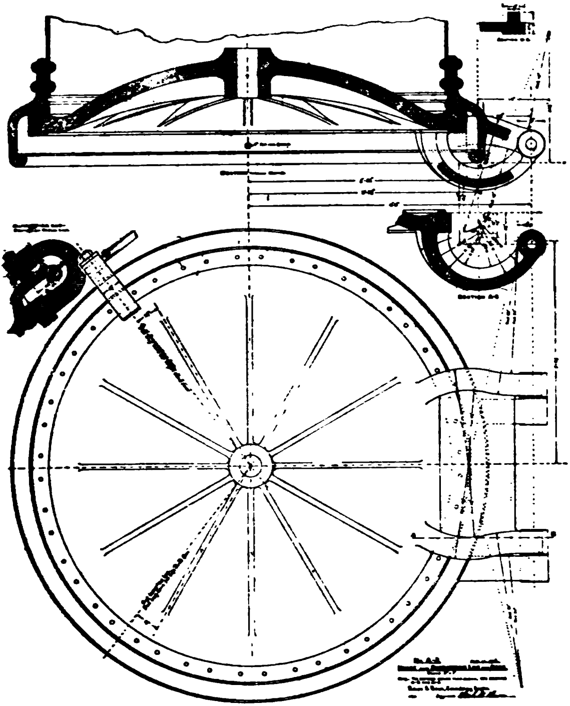
This should cover a complete plant with the best and most suitable wooden buildings, concrete foundations and everything ready to operate, not including lands or the standard railroad tracks in yard.

Any excess in cost we would deem due to unskillful designs or miscalculations.

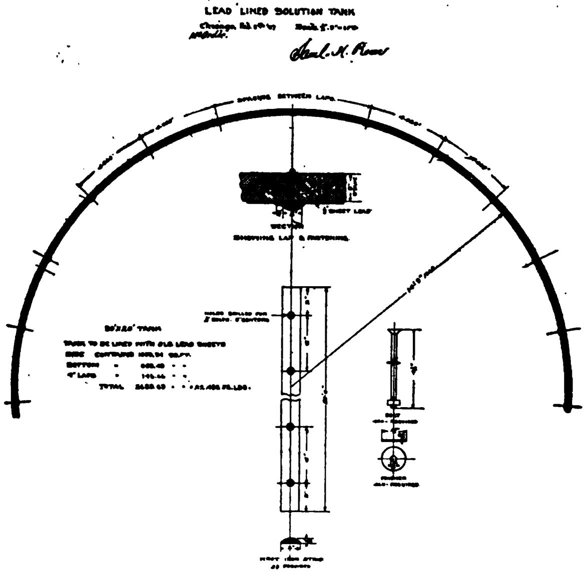
**Note.* When creosote oil is used there should be added for storage of stock of oil: first, a tank well

proportioned for accurate tank measurement and for special heating appliances called usually the "working tank" which must be of steel and of such capacity as to keep on hand hot oil sufficient for the operation of the plant.

Secondly, a steel tank of sufficient capacity to store three months' stock of creosote oil. The cost of this stone tank, estimated at about $3,500, should be added to them marked with star. (*)



CAST STEEL HIGH PRESSURE RETORT DOOR AND FLANGE. (ROWE & ROWE.)



LEAD LINING FOR WOODEN TANK.
(ROWE.)

CHEMICAL TREATMENT OF TIMBER

[Engineering News]

The stress now bearing on the railroads of this country, owing to the increasing difficulty in procuring wooden cross-ties and their rapidly increasing cost, has forced attention to the necessity of method of prolonging life and to broadening the field of supply.

The question of still further broadening the field by resorting to metal has been suggested, but it is to be apprehended that the greater cost of metal and the superiority of the wood will bar this for a long time yet.

While the chemical treatment of the wood has been resorted to in this country for a comparatively short time and only in isolated cases, enough has been learned to demonstrate its value and to prove its economy and its adaptability to a great number of timbers not heretofore suitable or valuable for this purpose; thus very much broadening the field of available supply.

Many tentative efforts in this direction have been made in this country during the last half century by various processes and by various agencies, but owing to the less amount called for and the abundance of timber of the best quality, of tie timber there was but little advance made.

Now that the railroads are, using a slang but very expressive term, "Up against it," attention and interest compels action and no one subject connected with railway maintenance is being more generally discussed. Not only discussed but action is being taken, and a strong desire evinced to take the best means to make the action effective.

Up to this time, two agents have been employed, that of Chloride of Zinc and Oil of Coal tar (Creosote), the latter the most effective but the former most economical.

Results so far in this country show that by the Zinc-Chloride treatment the life of the soft woods

is more than doubled, meaning a mean life of from eight to twelve years for pine that usually lasts from two to five years. It must be understood that this is the mean life, the actual life being from five to over twenty years for the treated pine ties against two to seven years for the untreated ties.

The treatment with creosote gives perhaps twenty-five to fifty per cent. more life than with the chloride treatment, but at from three to four times the cost with the same timber in both cases with the further difficulty that many of the timbers that it may be desired to treat, cannot be penetrated except superficially.

We propose here to notice the various methods resorted to, and proposed to be resorted to in the impregnation of the timber:

First: The Chloride of Zinc.

Second: The Zinc-Tannin.

Third: The Creosote or dead oil.

These comprise all that have been tried in this country of which we are able to offer extended records that are authentic enough to be gainsaid: the first, that of the Southern Pacific Railroad with a mean of eight and a half to nine years for Burnettized pine ties and in the second case near twelve years for pine ties on the Atchison. Of ties treated in 1885 and removed in 1905, twenty years in track, 4,600 are near four per cent., and there are doubtless still some of the 1885 ties still in track in spite of mechanical wear and notwithstanding that a large part of the line on which these 1885 ties were laid has been ballasted with crushed limestone ballast by which some were prematurely removed.

Of course efforts are being made to discredit this agent by those whose disinterestedness is open to suspicion, and the statement is being made that the chloride treatment has been abandoned in the old countries,—for what reasons?—and that creosote alone is effective. We will surmise that there may be another reason for its abandonment,—that of the cheapness of creosote oil which but a few years ago

was almost unsaleable, there being but a limited demand for it. This is a surmise by no means discrediting the chloride process, and a condition no longer possible under present conditions and so valuable an agent as the creosote can never be much cheaper than now.

Unless the price of creosote oil can be held below present prices its use cannot be economical for railroad ties where ten to fifteen pounds to the cubic foot is required, and even twice this is sometimes absorbed by the softer pines. In case where piles are treated especially used in salt water to protect against the Teredo, the largest amount is justified both for effectiveness and on account of the limited quantity of timber used.

There is no question but that the creosote oil is a valuable agent for the purpose. My attention was called recently to a case where Southern short leaf pine ties were treated with creosote in 1880-82; near seven per cent. were still in service at twenty-four years. In 1885 Zinc-Tannin treated ties, four per cent. were still in at near twenty years, a parallel which seems to be about the relative value of these agents. It would be well to remember that these soft wood ties are likely to fail under rail and spike wear at less than twelve years.

The combination of these two agents is a newer field that is well worthy of exploration, holding in mind however, that sound business policy which we expect from railroad managers, will require results before employing such an amount of capital for a plant commensurate with the great quantity of timber to be treated as well as the cost of operation and chemicals, without some assurance of the desired result when they have done so. It would hardly be safe to assume that the reduced amount of oil proposed (four to six pounds per cubic foot) could be relied upon as effective until demonstrated by time and test.

Two of these methods are the Rutger Zinc-Creosote and the Ginssanni in which both creosote and

chloride of zinc are intended to be combined; the former is an emulsion; in the latter by first boiling the timber in hot oil and then plunging it into a vat of cold chloride of zinc solution. The Ginssanni process would seem to be a fair treatment for railroad ties if the absorption of the chloride is complete, but seems to be only effective as to penetration in very soft open wood. Were the penetration of the chloride complete even if the oil penetration was only partial, between the two it should be a very fair treatment for the soft timbers.

The Rutger or zinc-creosote process has been under trial for many years and as the oil penetration even in the red oak seems to be quite complete and that of the chloride quite as complete as in the Burnett and the Zinc-Tannin, there is no reason why it should rank with them with a strong probability of even better results. I have not the records at hand to show what the average life of these treated ties is. Mr. Octave Chanute estimates mean life above that of the Zinc-Tannin.

The Rueping process is also a process seeking complete penetration by a partial dose of oil. It is based upon the principle that the only way that complete penetration can be secured is by means of a strong compression of the air in the wood (usually 35 to 40 per cent. of the volume of the tie), applying 60 to 80 pounds of air pressure on the charge and then while holding this pressure forcing in the oil by using twice this pressure on the charge until the wood is impregnated, thus releasing the pressure and allowing the compressed air to force out a portion of the oil. The result is when six pounds of oil per cubic foot is introduced, or rather forced in, about two pounds will be returned, four pounds remaining in the wood. My observation shows that the softer and open grained woods are well impregnated but that some of the more compact woods cannot be well impregnated, when it is practicable to permeate the same woods with chloride of zinc as in the Burnett or Zinc-Tannin, Zinc Creosote, etc.

The means taken in the Rueping process to extract a portion of the oil are the best and most effective known, but the doubt still remains as to the utility of using a limited dose of oil. When we have a few years' time to observe results we shall be better able to judge, but it would seem worth while to try it by those that have the means and are willing to incur the expense. The probability seems to be that the results should be equally good with the chlorides.

The use of a vacuum for the extraction of oil once forced into the wood will not do it beyond the amount that will paint a dry tie, say one pound per cubic foot, we judge as with the aid of the hardly compressed air as applied by the Rueping operation will only bring out 30 per cent. of the six pounds introduced. A larger amount can be forced in if a higher pressure is applied and the compression of the air in the wood be omitted, but it will be done to the serious injury of the wood fiber by forcing in more than the natural voids of the wood will hold. Immediately on removal of the high pressure the oil will commence to reject this surplus and will continue to do so until the timber returns to its normal condition, the surplus oil meantime going to waste. The true policy in timber impregnation is to *induce* rather than force permeation. This is believed to be largely due to the steaming.

The methods used for securing impregnation of the timber by inducing the absorption with a moderate amount of heat and such degree of pressure upon the solution or oil has been quite generally followed for many years, in the Burnett, the Zinc-Tannin and in Creosoting. It consists of:

First, steaming; second, application of the vacuum; third, the introduction of the solution or oil. That this has been the best and most effective seems to be quite apparent. It must be remembered that this program was established and practiced for the last forty years and its correctness has not been seriously questioned until recently. And furthermore, those disputing its propriety or correctness as meeting the

physical laws and conditions seem to be questioned either by new students of the matter without sufficient experience to grasp the matter in all its bearings, or by parties with some new patent or device and with self interest as the main impelling motive.

The application of steam to the timber is claimed to be both unnecessary and injurious, especially under high pressure. In the above cases experience shows that above about twenty pounds per square inch is injurious, hence this was made the rule. It is, and has long been known that the fiber can be destroyed by steam as the fact is known that under very high pressure steam pipes will show a red heat.

It has been claimed and loudly proclaimed that twenty pounds steam pressure will reduce the strength of steamed timber 25 per cent. More recent careful tests by a well known and capable chemist seem to indicate that the injury is nothing like this and proves so small that it may be safely ignored. Farther investigation may show the entire fallacy of this too hasty conclusion.

But no matter. We know that the steaming performs a very essential part of the process, fitting the wood for absorption of the chemicals, heating and dissolving the juices, and filling its place with expanded vapors by which the air is largely exhausted by the aid of the vacuum following. No other agent can be used to bring this condition about so effectually. Not only this, but the fiber of the timber is softened for the time and eventually toughened much as if the timber had been air-dried for a long time. Subsequent examination of the timber of railroad cross-ties shows that the spike drives with less injury to the wood, holds better and that rail wear is very much reduced. This is believed to be largely due to this steaming.

Then, again, while much has been said about the necessity of air-drying ties for several months before allowing the timber to be treated, which is conceded as desirable in some cases, in others, impracticable as with the loblolly of the south in which case as

well as with ties from the mountains of the Republic of Mexico, rot so as to be useless in two years if not treated, as decay will commence in a week and progress far before they can possibly be air-dried.

Any one well versed in the matter knows that under ordinary conditions where a large plant is in operation that it is impracticable to thoroughly air-dry all the ties before treating. Some ties dry in a comparatively short time, while others require much more time. It is hardly worth while to argue the matter farther as we know that the bulk of ties treated to-day are not all dry and that the enforcement of such a rule is impracticable.

Then again, there are many timbers that are more easily impregnated when freshly cut than dried, such as the pines and fir of the Northwest as well as those of the Pacific Slope.

Then again, there are timbers that can be impregnated by steaming and the use of the Chloride of Zinc with the greatest difficulty and with creosote, not at all. Conceding this view, then it follows that not only can green fresh cut ties be impregnated but any mixed lot can be brought to a uniform condition by steaming.

There can be a gallon of dissolved timber juices per cubic foot of timber, or in other words something like twenty pounds taken from the tie. This is supposed to be solid matter dissolved and drawn out by the steaming, and we have a right to suppose that it consists of germ food, largely.

The rule of allowable pressure of one hundred pounds per square inch while in solution or oil has also been criticised and the assertion has been very emphatically made, that higher pressure will not injure the timber fiber even up to 600 pounds per square inch. We know that 200 pounds will come near opening up a piece of oak and will check an ordinary railroad tie and admit more solution than will fill every void twice over. While this would not materially injure the strength of fiber it will cause easy

parting of the wood and admission of water later to the more rapid decay.

Those who are using the Zinc-Chloride have been somewhat concerned by the claim made that the Chloride of Zinc leaches out of the timber rapidly. An effort has been made to do this by long continued and oft repeated series of immersions in water, drying and analyzing, shows that a small, regularly decreasing amount does waste out but after near eighteen months only 28 per cent. of that absorbed originally, was extracted.

The writer has worked for many years in the interest of honest and effective work in relation to this subject, giving to every phase of the conditions to be met and to the solution of every phase and condition and to every principle involved. Long and patient experiments have been made in relation to every point involving every one of those embodied in this article and it is believed that while their correctness in many cases is denied and by others criticized as incorrect, yet it is believed that they will be sustained eventually. The Forestry Service has been organizing a force to systematically investigate the whole matter with a view to settling authoritatively many or all the disputed points and to this we will look forward with much confidence. In advance of such however, we are willing to stand by what we have written even though overridden by a flood of objections.

From present knowledge we will not believe that a better knowledge of the matter exists in any foreign country, even Germany, as knowledge has never come freely from that source in particular.

Goethe, the great poet, over 100 years ago exclaimed with impatience, "The Germans have the art of making science inaccessible," and Baron von Humboldt supplements this by explaining that "An edifice cannot produce a striking effect until the scaffolding is removed."

If in fact men of high abilities have built up the industry under consideration, what was true 100

years ago is yet measurably true to-day, and those essential principles and methods involved in the art, and art it is, have been very careful to obscure their knowledge, and are not in condition to-day to prove their pre-eminence in knowledge or in priority of discovery. What we have been favored with has been through our scholarly Octave Chanute, C. E., and we doubt whether any more thorough knowledge and experience has been attained in Germany than here.

A revived candidate for favor that is being promoted is that of Vulcanizing, or in other words, roasting the wood. Whether sufficient heat can be employed without burning the timber seems doubtful. It seems probably that the same result, to wit, thoroughly seasoning, can better be secured by judicious steaming which is about the only method that will guard against burning the fiber In kiln drying lumber resort is being had in moist air; (Or in other words, steaming under light pressure) instead of using dry hot air.

More light is needed before we can judge as to the value of the Vulcanized process.

Chicago, Dec. 7, 1906.

THEORY OF STEAMING TIMBER

CHICAGO, April 30, 1905.

Mr. A. A. Robinson, President, Mexican Central R. R. Co., Mexico City, Mex.

DEAR SIR AND FRIEND:

Introductory to the subject of your letter, I think it well to refer back to the time over twenty years ago, when all the information I was able to acquire was mainly from the patentees who then owned the "Wellhouse Process" as to the whole method of the operation and the philosophy and physics; and when the whole responsibility for the proper operation was placed upon myself, I considered it my duty to do as I have done in every case in my many years of active duty on questions of railroad engineering and

constructions, to go to the bottom of it if possible. In this case I was able to enlist my son who succeeded me the following year. This study formed the basis of the journal then commenced as a necessity to the direction of the operator of the plant. To this has been added the information derived since by years of labor and thousands of dollars of expense and which I send you under separate cover, as 1906 Edition of "Preservation of Timber." Undoubtedly, there are many errors, of some of which I am well aware, which should come out in a revision. This I can find neither time nor means to do at present. You will see that almost every essential element and physical principle involved in the operation of impregnating timber under the Burnett, The Wellhouse and almost all other processes, have been investigated with great care and I believe that my conclusions will be found correct and that they will benefit the honest student.

Since I have fallen back on the planning and installing works for a living and have erected some very good plants, most of which are in efficient and effective operation, the tendency of humanity to experiment has led to questioning some of the rules laid down originally by which good results have been attained, among which is the one in hand. I think however, that the preponderance of evidence is still in favor of the correctness of those laid down including the steam seasoning.

A man goes to Germany about three years ago and talks with the timber treaters there, returns and immediately enters the field as an expert in the business and also immediately concludes that the chloride of zinc treatment was a failure in this country.

One of the hardest things to understand is that he, through governmental backing, impliedly, if not actually succeeded in holding up the whole business in this country in a measure, and not only this, to throw discredit, both on the many workers and upon results obtained. Not only this, but the schemes of various promoters have been taken up, and exploited

some nonsensical and some that when properly proven by time, may be of value, but that any one with so short an experience should set himself up as an authority is almost incredible and shows but little conception of the broadness of the whole question.

By a series of experiments he proves that steaming weakens the timber. This was known many years ago, as was the fact that excessive heat applied by steam or by any other means would burn up the timber. Witness the effect often seen in creosoted timber where super-heated steam had been used.

Therefore, the conclusion by implication is that Creosote and Creosote alone is to be the successful agent.

It is well to mention in this connection, that he has lost sight of the fact that many of the timbers that should be treated cannot be impregnated without steaming, and again, that some timbers like the loblolly and the old field pine cannot be dried for any considerable time without going far toward decay.

Then again the universal use of dead oil is impossible first, because but a minor portion of the timbers that should be treated, can be impregnated by any known practicable means, and again, it has long been known that creosoting is too expensive except for special cases where specially long life is sought.

Now let us see that all is thus ruthlessly brushed aside. In 1885, you ordered the Las Vegas works erected to use the chloride of zinc, or rather the Wellhouse or Zinc-Tannin process in the impregnation of the Rocky Mountain Pine ties. At that time you gave me a sample of a cross tie treated for the most perishable timber which had seen seventeen years' service in track, yet perfectly sound which in itself was a fair assurance for the future and an apparent justification for an appropriation for works and the necessary stock of chemicals, etc., yet a large sum for those days.

Now, as to the results to-day.

The mean life of the untreated ties (pine) 1880 to 1886, five years, was computed to be four and a half years as in 1886, over three quarters of the ties laid in 1880 were taken out rotten so completely as to be entirely worthless for fuel. The next point to note is that the treated ties were found to remain entirely sound until the sixth year with a very small percentage on the sixth year principally from breakage and mechanical wear.

Then again, assuming that removals do not commence until the sixth year as is also true as to hemlock ties treated by the same process by the Chicago Tie works, we take all the ties laid and removed from track from 1886 to 1900 previous to 1905, some 4,560,000 or about 28 per cent. of the total treated and laid, including failure from all causes at an average of life of ten and two-thirds years.*

The Santa Fe record is not as complete as we could desire, but its trend is unmistakable, showing that we get a mean life of nearly twelve years as against four and a half years for the same kind, of ties untreated.

From time to time, appeals have been made to me as to the admissibility of the omission of the steaming. I can only point to the above record, as beyond this, I DO NOT KNOW. In my experience I see much to lead me to believe that loss will be incurred by its omission, or in fact, any omission from the original Wellhouse program.

Quoting from your letter: "From the very nature of the case, it seems to me that the idea that the ties must be seasoned is fallacious for the reason that the chief point in securing good treatment is to draw from the timber the juices, saps and acids contained in the wood, and it seems to me this can be more readily done before they are dried out and while they are in their liquid state."

**Note.* I have removals just reported by Mr. Faulkner for 1905 showing that 4,600 of the 111,000 ties treated in 1885 were taken out in the twentieth year of service.

Confirming your views above quoted it is a fact that the timbers in the west slope of the continent are best treated direct from the mill and these timbers cannot be penetrated without steaming. My experience at Kalispell, Mont., confirms what Mr. W. G. Curtis and Mr. Isaacs of the Southern Pacific R. R. Co. have long insisted.

Another omission, should be mentioned, that of the glue and tannin.

It was early complained that nobody could find the leatheroid. The trouble was that they looked in the wrong place. In Wellhouse treated ties in Texas it was early observed that with the loblolly (the most perishable timber) in ties where the corrugated tie plate rested, that the surface of the tie was cut into, presumably breaking the protected tie so that the timber rotted away in the form of an inverted bowl leaving the body of the tie measurably sound.

The true place to discover the protecting quality of the leatheroid is in the general appearance and condition of the tie after six or eight years' exposure in service and comparing it with the Burnettized or even with the untreated tie. To those able to read as they run, this will be quite apparent in what I call the "integrity of the tie." I know no better name for it, where the tie is full and sound long after untreated ties have started to go in pieces or even those Burnettized.

Further omissions may be suggested with a view to saving any expense whatever, but it seems as if the economies secured at the expense of ten to twelve cents per tie, that the rules under which the before mentioned results are secured are best adhered to until something better is devised and proven.

By the careful observer, the omission of the steam seasoning as suggested, comes largely from the commercial side in the discussion. Mr. Phillippi's quotation from my book which expressed the belief that the steaming was an essential part of successful impregnation as well as a seasoning of the timber, drew forth "left-handed applause" from the com-

mercial crowd that, unfortunately, due to the reason mentioned at the opening of this letter, seemed to dominate the convention.

Certain matters in relation to timber impregnation seem to be fundamental, among which are:

First: No iron clad rule or specification can be drawn to cover the handling of every timber condition and every part of the country; to believe it possible will indicate but a limited conception of what such an undertaking comprises. Only honest study and extended experience with the added COMMON SENSE will meet each and every case.

Second: That some timbers can only with the greatest difficulty be impregnated by the aid of steam and the vacuum; without, not at all.

Third: That if desired, timber cannot always be secured uniformly dry, and that some timbers cannot be treated at their best when delayed to be thoroughly dry, as before stated.

Fourth and lastly: Creosote cannot be utilized to the exclusion of the Chloride of Zinc and other agents; first, because many timbers cannot be impregnated by any known practical process; secondly, as to railroad cross-ties on account of excessive cost with timber that can be impregnated.

In conclusion I call attention to the fact that we have thirty-seven years' evidence of the value of the Wellhouse or Zinc-Tannin and it seems the proper thing to keep it until something better is offered with at least a reasonable record.

I must beg your pardon for this long dissertation but you must understand that is done under severe provocation and in a case where a man feels like sharing the stress with another.

With kindest personal regards, I am,

Most respectfully yours,

(Signed) Samuel S. Rowe.

PROGRAM FOR TESTING AMOUNT SOLUBLE MATTER REMOVED BY STEAMING

In the impregnation of timber, whether with oil or with zinc chloride, the present practice is to submit the timber to the action of steam, the vacuum and finally to direct contact with the oil or solution with a certain degree of pressure. We can weigh the charge between and after the treatment and the increased weight may be taken as the actual amount absorbed, but it will invariably be found that this excess or increase in weight will not equal the actual amount drawn from the tank. To account for this, we should inquire what takes place during the process, it being evident that so much of the solution or the oil is lost in some way, or that during the process of steaming something is extracted from the timber during its contact with the steam. The latter is the most probable and indeed it is easy to see that much of the timber resins and juices appear in the off-fall to the sewer during the steaming, but how much of this is timber sap and how much is condensed steam cannot be easily determined.

Ordinary observation will show that the steam does not disturb the insoluble cellulose or wood fiber matter in the wood. If we weigh very dry timber after drawing the vacuum we find that it is slightly heavier than before, but if we do the same when the timber is green and sappy, we find it considerable lighter; hence we have reason to infer that a larger amount of sap has been extracted from the green than from the dry timber.

Further than this what takes place during this part of the process is not known, or at least has never been published by those knowing.

If we weigh before introducing again after steaming, again after vacuum and finally after withdrawing, we may gain some knowledge.

The temperature of the timber at each stage if carefully taken might aid too, as it is quite important to know this in connection with the former

facts and the time required to treat the wood clear through.

The thermometer could be introduced into holes previously prepared, deep enough to allow the bulb to reach the center. This of course would give only an approximate, but near enough to give a fair knowledge of the temperature of the wood at each stage.

Various experiments are being made, at what cost remains to be proven, among which are the substitution of the Burnett for the Wellhouse process and the omission of the steaming from each. One more omission would bring us back to the point of starting, where 20 per cent. renewals are required instead of 6 per cent. as has been demonstrated.

The omission of the steaming, even where the wood is exceedingly dry still leaves something lacking in the process. The absorption of so much chloride may be attained without difficulty, but the juices of the timber remain—one of the important matters at which the steaming is aimed and which cannot be reached in any other way.

This is more important with some kinds of timber than others as the sugary saps go much farther in the promotion of decay than the turpentines, but in case of the latter there are elements that are better removed. It is hardly conceivable that a railroad company will experiment in this way, and I believe that if the facts as to results so far were closely studied and more freely disseminated, that its unwisdom would be apparent.

There has been so much tendency to pare down and belittle results under the idea of being conservative, that the whole matter has been thrown under a cloud of doubt.

A more sanguine treatment would seem genial and wiser, particularly as in keeping the records, failure from other causes than decay are inseparable in the summing up. Ties destroyed by derailment and from decay taking place before treatment and

breakage or crushing from overloading swell the failures even in the earlier stages.

The purpose of this paper is to encourage this investigation by the co-operation of several of the operators of existing works and to be able to compare the results for the benefit of all.

The following program is suggested as meeting the case, to wit:—

First; weigh the last two cars in, these being the most convenient to get at, before closing retort.

Second; take out and weigh, when steaming is completed, at the same time taking temperature.

Third; again weigh after vacuum, again taking temperature.

Fourth; again weigh immediately after withdrawing charge.

The Fahrenheit thermometer requires a quarter-inch hole with a bit cutting a clean hole to the center of the tie and can be introduced and read in a minute or two, giving at least an approximate. Suggestions are in order.

(For results, see Table on Page 184, ante.; also New Tests at Evansville.)

CHICAGO TIE PRESERVING COMPANY

TERRE HAUTE, IND., Nov. 8, 1906.

Mr. Samuel M. Rowe,
Chicago, Ill.

DEAR SIR:—

In reply to your letter of Nov. 1st, I have made several experiments within the past month on red oak ties, in order to ascertain the amount of creosote oil that can be withdrawn from the wood by means of a vacuum. In these experiments the oil was admitted to the cylinder without exhausting the air from the wood first.

Where oak ties are well seasoned and weigh from forty-five to fifty pounds to the cubic foot, I have been able to withdraw from one to two and a half pounds of oil per tie with a twenty-six inch vacuum maintained for one hour. The wood in this case, being well seasoned, will yield but a very small

amount of oil when the vacuum is applied. Where the wood is not so well seasoned, and weighs in the neighborhood of fifty-five pounds to the cubic foot, more oil can be withdrawn, as the oil does not penetrate to a very great distance. In this case I have been able to withdraw from three and a half to five pounds per tie in one hour, with a vacuum of twenty-six inches.

Oak ties will absorb from two to three times as much oil if the air is first withdrawn from the wood than they will where the oil is forced into the wood without exhausting the air; and for this reason it is impossible to withdraw but a small amount of oil by means of a vacuum. A tie that is in condition to absorb fifty pounds of oil, will take only from twenty to twenty-five pounds of oil if the air is not first exhausted. Therefore it will yield but a small amount when the vacuum is applied after treatment.

In the Rueping process where eighty pounds' pressure of air is first maintained for one hour and the oil then admitted without destroying the air pressure, I have found it impossible to inject into a red oak tie more than from five to ten pounds of oil per tie with a pressure of 180 pounds per square inch for three hours.

Average volume of the ties used in this experiment = 2.75 cubic feet.

Very truly yours,

J. B. Card.

Note: This letter is here deemed worthy of preservation, as Mr. Card is a son of J. P. Card, deceased, one of the earliest and best authorities on timber preservation in this country; and his experience has been long and continuous. What his tests here given show, is well worth pondering as relates to the amount of oil withdrawn.

(Refer to P.—Over pressure.)

WASTING AWAY OF CHLORIDE OF ZINC

In the treatment of timber by the use of the Chloride of Zinc almost the first impression that strikes the new investigator is that owing to the extreme solubility of this chemical salt it is liable to quickly waste away. Without further argument the conclusion is drawn that it is quickly exhausted and that decay at once sets in, and the fact is that the arrival at this conclusion is generally considered sufficient to condemn it as a preservative.

This conclusion is fallacious from the fact that it is based upon wrong premises. That there is some waste is conceded, but that this waste is of sufficient importance to condemn the Chloride of Zinc as an agent to prolong the life of the timber is all wrong. The Wellhouse process (Zinc-Tannin) is based upon the idea of reducing this waste.

The amount of this waste may be judged by exposing the treated tie to frequent exposure of the piece to a series of exposures to the most severe conditions possible, that of placing the piece in water, removing and drying, the analysis as to loss and then repeating this for a long time.* The waste shown by analysis was found considerable at first, but gradually reduced at each trial so that after several tests the loss almost ceased and the total loss proved that less than 28 per cent. of the original amount had been extracted.

By relying on test of treated ties after long exposure, is often misleading. A tie in which decay has far progressed before being treated will be found in after years to contain much of the Chloride still present, while a sound, well impregnated tie will be still sound after many years of exposure, retaining but a trace. The fact is that a well grown, close grained wood does not take anything like the quantity of the chemical in the first place, and does not need it. Common sense should make evident the futility of treating wood where decay is more or less

*(Experiments made by F. J. Angier, when the test was carried on over a year).

present already and to treat such is a foolish and vain expenditure of money.

To Whom it may Concern:

The question has been asked: "How long will the antiseptic sap combination of chemicals stay in the wood after it has been injected?"

The answer to this question is, that the effect of the chemicals on the wood will remain as long as the wood lasts, for the reason that it destroys the germ upon which the agencies combine to cause decay. The absolute penetration of the chemicals into every part of the wood, destroying the germs, is what prevents the heat, air and moisture from having anything to work upon to generate the growth of fungi, or to cause fermentation, which means decay.

In treating green lumber, the cells of which are filled with sap, the chemicals combine and oxydize the sap, making it a part of the preservative.

In treating seasoned lumber, where there is no sap to be combined with the chemicals, the chemicals being a preservative within themselves, act only to kill the germs remaining in the wood.

The chemicals are of such a nature and combination that either green or seasoned lumber can be treated without the use of the dry-kiln, which so often impairs the value of lumber by overheating.

After the solution has done its work of destroying the germs, evaporation takes place which leaves the wood filled with the oxides and carbonates, chlorides and sulphates to act as a preservative to prolong its life and lessen its liability to check and warp.

Should climatic conditions reduce the amount of any of the chemicals, it will not reduce the effect produced, for the reason that the chemical action so changes the original condition of the wood that all germ-matter which generates a fungus growth is destroyed.

We should rather look to the results of the treatment as shown by the records of results in the prolonged life of the tie under service, and by taking

into consideration all the conditions under which the tie has passed in being treated, and deduce therefrom a much more philosophical explanation of what has taken place. Even if there is some waste during subsequent years, it is not clear but that the chloride has done its work in the resolution of the elements of decay thus preventing decay for a long time. The result seems to indicate that this is true when we take into consideration the well attested fact that very little decay takes place in six years and an average of near twelve years' life is secured with a timber that decays beyond any use in six or seven years and a mean life of not over five years.

Possibly this same philosophy may be applied to the action of creosote, particularly as relates to the more volatile ingredients popularly supposed to be of little value. Like the work of the chloride, it may do valuable work while it is evanescent and entirely disappears.

The primary effect of this may be somewhat as the disinfectant used in cases where an infectious disease has existed; it does its work at once in the fumigation of the clothing and the premises, no repetition being needed.

OVER PRESSURE ON TIMBER

CHICAGO, Sept. 17, 1906.

MY DEAR ANGIER: Your welcome letter of the 10th inst. came to hand to-day. The main point of your letter is in regard to effect of pressure to which the wood is exposed in the sealed retort under high pressure. I do not think that wind pressure on the standing tree is a parallel at all. We know that overstrain on the tree results in what are termed "Wind-Shakes," but that they arise from that pressure that gives place to inflow of a liquid far beyond the natural capacity to absorb, or in other words, beyond the natural voids of the wood we cannot see.

One of the first experiments made on my small laboratory plant showed that with 300 pounds' pressure on paving blocks of similar dimensions, an excessive amount was injected, so much in excess of the known capacity of water-logged wood and in excess of what can be retained that the solution was still flowing out twenty-four to forty-eight hours after removal from the retort. Of course this effect would be magnified by the short length of the blocks over timber of considerable length, but it demonstrates the effect only of the increased degree, the principle and the effect being the same.

In the case mentioned where the blocks were subjected to 300 pounds' pressure to impregnate, the absorption was 58 per cent. of the volume of the timber, while the average absorptive power of the pine is about 27 per cent. in volume. This is twice what the timber will hold, consequently the over-plus will waste out.

If you will visit some of the Creosoting Works where piles are treated under 150 pounds to 180 pounds pressure, you will see the same effect only in less degree.

Similarly in treating paving blocks where the creosote was loaded with an equal amount of bitumen, one charge was impregnated under 200, the amount ultimately held did not differ greatly except

that the oil could be pressed out of the end by the strength of the hand in case of the former, while the latter was quiescent.

Over twenty years ago I had the advice of Mr. J. P. Card and Mr. Wellhouse, the patentee of the "Zinc-Tannin" process, as my tutors in the business of timber impregnating, the latter having then some eighteen years' experience in the business. As a result of this experience was the iron-clad rule, "not to exceed 100 pounds' pressure." Since then I have found a tendency to try to hurry absorption by using a higher pressure. I confess to allowing the trial but in no case has the result been found appreciable as to expediting absorption.

I would call attention to a marked characteristic of ties treated under this rule and those subsequently treated, where attempts have possibly been made to hasten the operation by using the higher pressure. The former, even in later years of life, eight to twenty years after treating remain sound on top but with one main check in the middle of the upper side, while those of the latter treating part into numerous strips. Of course this might have proceeded from some other cause but the presumption is strong in my mind, as I know of no other cause so likely to have produced this particular effect.

I cannot help as to the Rueping or the Lowry processes you mention, where as high as 180 pounds per square inch is used; in the former, however, the required pressure has been reduced to a point where it would not be very excessive and a little damage to the timber may be allowable if thereby good impregnation and cheap treatment is secured.

I have always labored to treat every question candidly, and have labored many years, (finding myself) and have given to all the results of my labors, but when anyone tells me that I am all off in this matter and that 600 pounds will not injure the timber, I feel like challenging this most emphatically. The old rule of 100 pounds is given as the limit of all allowable pressure, the presumption being that

the 100 pounds will not materially injure the fiber. I have tried the injection of oil into a pile with an appliance by which I hoped to impregnate it at the ground surface and found that even the most solid oak would split at 150 pounds, but this is a different condition.

The 300 pounds of retort pressure may not materially affect the strength of fiber, but it is the after effect developed in the course of years by exposure to the elements, where the effect becomes of consequence.

In the summing up of the whole matter of timber impregnation, I think that it resolves itself into *inducing* rather than forcing, and that success largely depends on producing conditions by which the timber will take up the oil or the solution by the action of *natural laws*.

In the cases herein mentioned, short blocks were used, hence the effect was greater than with long sticks, yet this serves to demonstrate the principle in question. Under the 500 lbs. pressure the volume was increased five per cent. on withdrawal, while those subjected to 100 lbs. pressure were about one per cent. In both cases after two months' drying the volume returned to near the original volume.

SAMUEL M. ROWE.

Note: In creosoting it requires from 150 to 180 pounds to impregnate even the most open timber when in the shape of piles and even this pressure will not penetrate sawed dimension timber to any considerable depth, and in no case is the timber permeated to the extent that it is with the chloride treatment.

THE USE OF COMPRESSED AIR FOR SHIFTING SOLUTIONS AND OILS.

In the treatment of timber, the solutions and oils should not only be quickly shifted but what is still more important is that they should not be scattered and wasted but should be kept at all times so that the quantity shall be easily determined at each stage of the operation.

The practice of dumping from the retort and returning by means of a pump is not only clumsy and uneconomic, but renders measurement less prompt and less accurate. By means of compressed air it is cheaper and more promptly done and less subject to error.

The notes appended are from good authority, and are introduced here, as well as a very useful table for computations relative to air machinery and appliances.

With a view to increase the accuracy of tank measurement, where practicable to use a working tank of smaller dimensions, increased accuracy may be secured by reducing the diameter.

TEMPERATURE OF COMPRESSED AIR.

Atmosphere at 32 deg. F. compressed to 100 pounds pressure per sq. inch a temperature of about 340 degs. at point of discharge from compressor. When discharged into a reservoir confined in a pit whose temperature is from 80 to 90 degrees, it loses about 40 degs. As applied to a Timber treating plant and used for forcing back oils and solutions, it is from 15 to 20 degs. higher than atmospheric pressure when 15 pounds per sq. inch is used.

ECONOMY OF COMPRESSOR VS. PUMP.

Under a total head of 18 ft. the pump is the cheapest, 18 to 22 ft. the same, 22 ft. and above Economy in favor of the Compressor.

Table showing the relative volumes of compressed air at various pressures.

Guage Pressure. Pounds.	Volume of Free Air Corresponding to One Cubic Foot of Air at Given Pressure.	Corresponding Volume of One Cubic Foot of Free Air at Given Pressure.	Guage Pressure. Pounds.	Volume of Free Air Corresponding to One Cubic Foot of Air at Given Pressure.	Corresponding Volume of One Cubic Foot of Free Air at Given Pressure.
0	1.00	1.00	70	5.762	.1735
1	1.068	.9356	75	6.102	.1638
2	1.136	.8802	80	6.442	.1552
3	1.204	.8305	85	6.782	.1474
4	1.273	.7861	90	7.122	.1404
5	1.34	.7462	95	7.462	.1340
10	1.68	.5951	100	7.802	.1281
15	2.02	.4949	110	8.483	.1178
20	2.36	.4236	120	9.170	.1090
25	2.7	.3703	130	9.843	.1016
30	3.04	.3288	140	10.52	.0950
35	3.38	.2957	150	11.20	.0892
40	3.72	.2687	160	11.88	.0841
45	4.06	.2462	170	12.56	.0796
50	4.40	.2272	180	13.24	.0755
55	4.74	.2109	190	13.92	.0712
60	5.08	.1967	200	14.60	.0684
65	5.42	.1844			

A.

INSPECTION OF TIES IN TRACK.

This form is intended for use where treated ties are used partly or wholly. The first column to cover whole section, 1-2-3 up to 10,000 if desired, equal to two or three miles.

This page to give abbreviation of names of timber.

SAM'L M. ROWE, C. E.
Oct. 28 1906.

CONDITION:

Columns 7, 8, 9, 10 and 11, degree of decay.

CODE	KIND OF TIMBER	CODE	KIND OF TIMBER
A	Ash, White	Lw	Locust, White
Aj	Ash, Red	O	Oak, White
B	Beech	Ro	Oak, Red
C	Cedar, White	Bo	Oak, Black
Rc	Cedar, Red	Wo	Oak, Water
Ch.	Chestnut	Ba	Oak, Bois de Arc
Cy	Cypress, White	Po	Oak, Post
Cr	Cypress, Red	P	Pine, Mountain
Cw	Cottonwood	Sl	Pine, Short Leaf
El	Elm, Red	Ll	Pine Long Leaf
Wl	Elm, Hickory	Lp	Pine, Lodge Pole
F	Fir, Douglas	Pc	Pecan
G	Gum, Red	Pn	Pinon
Gw	Gum, White	S	Sycamore.
Hs	Hickory. Shellbark	Sp	Spruce, White
Hp	Hickory. Pignut	Sr	Spruce, Red
H	Hemlock	T	Tamarack
Hj	Hackberry	Bw	Walnut, Black
L	Locust. Black	Ww	Walnut, White

B.

INSPECTION OF TIES

Railway 190

[illegible] No.	Mile Post	Commencing at Br. No.	Stamp No.	Kind of Timber	Hewn or Sawn	Condition				Rail Wear
						Sound	¼ Rotten	½ Rotten	Rotten	

INSPECTION OF TIES IN TRACK.

RECORD OF RESULTS.

No matter what theories may be promulgated as to value of treatment of timber for prolongation of life, or how plausible these may be, after all, the facts are what count and are conclusive. Many attempts have been and are being made to determine the value of each method, but so far they are desultory and in a measure, unsatisfactory.

The subjoined forms are offered that some convenient and concise system may be adopted at small cost of time and money, by which a record may be kept that will secure the desired result.

The inspection and record may be made on short representative sections of the line from year to year by any competent section foreman. The section foreman who is competent to say when a tie should be removed should be competent to make the inspection.

One or two sections of one mile or even less should give the data desired for any line of railroad. This would give some idea of the life of untreated ties which we heretofore have only by guess.

The blanks "B" should be securely wire bound at the top on stiff backing fifty in each pad on the back of which sheet "A" shall be pasted so as to be easily refered to.

The sheets "B" should not be detached and the pad should be returned intact.

It is believed that to secure the most accurate record that all treated ties should be plainly stamped and notwithstanding there has been much controversy in regard to the best method of doing, we still believe that the stamping hammer shown on Page 37 is the best. The cost of stamping at the works before the charge goes into the retort is small and has the advantage of avoiding the neglect or imperfect performance of this necessary part of the operation. See Section 12, page 24.

It is easy to see that the value of any treatment can only be judged by careful record of conditions from year to year.

At this writing, no or very little record is found and even this is discredited by many writers who possess but limited knowledge of the facts, and seem to be in too many cases impelled by self-seeking motives, and too often accompanied by little or no practical knowledge. Now, how is it possible for those desiring the facts, and how is it possible to know them without an honest and accurate inspection long continued?

It is believed that any writer on this subject who has the good of the work at heart will avoid misrepresentation, secure in the belief that time will vindicate their position and can afford to wait while those who write without knowledge will find their record marked with signs of their mistake and a revelation of their motives.

THE ZINC CRESOTE (RUTGER) PROCESS.

Joseph B. Card.

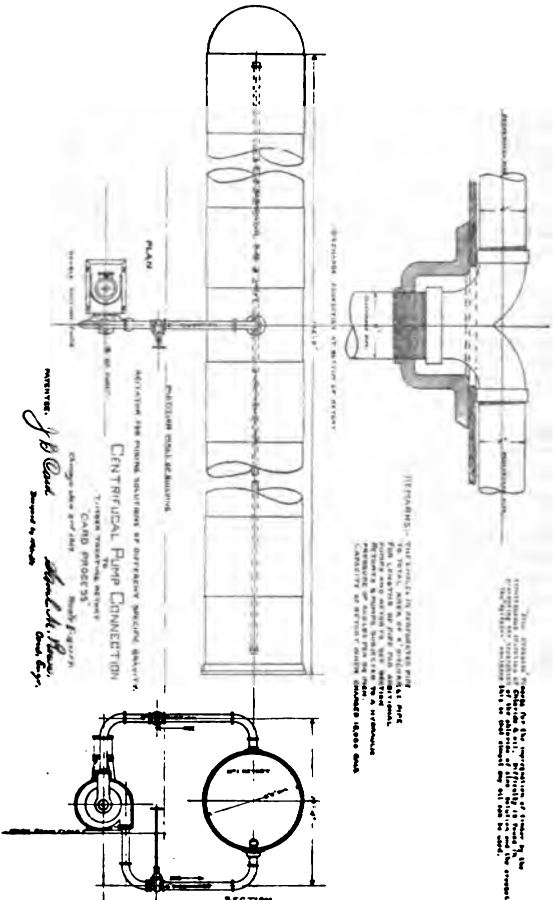
It is the desire of the writer to call attention in this article:

First: To the zinc-creosote process which is used extensively in preserving railway ties for the Prussian Railway Service, and to some extent in France.

Second: to an inexpensive method for agitating chloride of zinc and creosote oil while under pressure, which will enable the use of the above mentioned process in this country at a very reasonable cost.

In 1872 the German chemists agreed that by adding a small amount of creosote oil containing carbolic acid. to the chloride of zinc solution, much better results would be obtained in the preservation of ties than by the use of the chloride of zinc solution only.

As both the individual merits of chloride of zinc and creosote oil were well known, a combination of the two solutions was recommended, based upon the fact that the carbolic acid contained in the tar oil is


DISCHARGE CONNECTION AT BOTTOM OF RETORT
REMARKS:-
PLAN
AGITATOR FOR MIXING SOLUTIONS OF DIFFERENT SPECIFIC GRAVITY.
CENTRIFUGAL PUMP CONNECTION
TO
TIMBER TREATING RETORT
"CARD PROCESS"
PATENTEE.
SECTION

soluble in considerable quantities in a chloride of zinc solution, thereby the impregnation fluid could be made to penetrate more easily into the interior because with the addition of carbolic acid it has the capacity in a degree to dissolve the resinous contents of the wood. This cannot be accomplished with the pure solution of chloride of zinc.

In a paper by Mr. A. Schneidt, formerly Superintendent of the Imperial Railways, Alsace Lorraine, which was published in part by O. Chanute, C. E. the following theory is advanced:

"In the watery solution of the chloride of zinc, the carbolic (Phenols) acid contained in the tar oil added, is partly dissolved; and in this diluted form it penetrates the cellular tissue of the ligneous body far more readily and surely than the less readily fluid tar oil."

"The presence of carbolic acid also produces a potential solubility in the resinous constituents of the wood, whereby the chloride of zinc solutiòn is better enabled to penetrate the fatty resinous woody strata, and into the heart."

"In the judgment of chemists it may also be assumed that owing to the greatly attenuated degree of the chloride of zinc solution, and in the presence of the carbolic acid, a basic zinc "phenylate" is formed from the chloride of zinc oxide, through the agency of the bases of the salts which occur in wood ashes; and that this "phenylate" of zinc, being insoluble in water, favors duration by opposing the leaching out of the impregnated ties.

"The preservative action of the dissolved carbolic acid is decidedly more potent than that of the chloride of zinc; and as carbolic acid is also much less soluble in water than chloride of zinc the addition of a small quantity of tar oil containing carbolic acid will also arrest the decay of the wood which absorbs it. The heavy oils of the added tar oil do not as readily penetrate the wood as the more fluid solutions of chloride of zinc when reinforced with the dissolved carbolic acid; the former oils remain in

the outer woody layers of the tie, and form a very thin stratum, more or less obstructive to the entrance of water."

In 1874 Julius Rutger who operates most of the tie treating plants in Germany, introduced for the first time what is known to-day as the Rutger process.

At the present writing the process consists of injecting the equivalent of not less than one-third of a pound of the dry salts of chloride of zinc per cubic foot, and in addition to the four and a half pounds of creosote of oil per tie. At the expiration of the first ten years after the process was introduced, the Prussian Railways began to see that the results obtained from ties treated by the combination of chloride of zinc and creosote were giving much better satisfaction than ties treated with chloride of zinc alone, and the new process rapidly grew in favor, so much so that at the present time all of the pine and beech ties used throughout Germany are zinc creosoted. The average life of ties treated by the Rutger process on the Prussian Railways is from twelve to sixteen years.

The French State Ry. at the International Railway Congress in 1900 reported a life of sixteen years for zinc creosoted beech ties. The records of the road show that ties treated by the Rutger process last 25 per cent. longer than those treated with the chloride of zinc only.

The Rutger process was introduced in this country in 1904, by the Chicago Tie Preserving Co., at Paris, Ill., on the Big Four Ry. The use of this process, (when the solution is not agitated while under pressure) necessitates the importing of a special oil made by Rutger, in order to obtain a mixture which will not separate during the time the pressure is applied to the ties. This has been found to be expensive and at times hard to obtain.

This objection can be overcome by the use of a centrifugal pump the suction being taken from the top of the treating cylinder and the discharge en-

tering the bottom, being distributed uniformly the entire length of the cylinder by means of a perforated pipe. The pressure on both the suction and discharge side of the pump is the same as the pressure on the treating cylinder, therefore very little power is required to handle large quantities of the mixture. A perfect agitation can be obtained in this manner, and any good grade of oil can be injected into the wood together with the chloride of zinc solution, regardless of the specific gravity of either.

As it has been demonstrated beyond any doubt both in Germany and France, that a small amount of creosote oil injected simultaneously with the chloride of zinc solution, will increase the life of a zinc treated tie 25 per cent., it can be readily seen that the small increased cost of the zinc creosote process will more than pay.

The records in the United States compare very favorably with the German records where the chloride of zinc process is used and it is reasonable to assume that by adding five pounds of creosote oil per tie to the chloride of zinc solution, the same increased length of life will be obtained in this country.

The Santa Fe Railway shows eleven to twelve years' life for Burnettized ties, and the Chicago Tie Preserving Co. shows about the same on over 6,000,000 hemlock ties treated for The Chicago, Rock Island & Pacific Ry. On the Chicago, Eastern Illinois Ry., over 2,500,000 red and black oak ties have been treated by the Chicago Tie Preserving Co. in the past eight years about 950 ties have been removed for decay to Nov. 1st, 1906; undoubtedly the average life of the treated oak ties on the road will be not less than twelve years.

If the life of these ties can be increased 25 per cent. by the addition of a small amount of oil the extra cost will more than pay.

The cost of a zinc creosoted tie is but a trifle over one-half the cost of a creosoted tie which contains from twenty to twenty-five pounds of oil, and the results will be the same, as the creosoted tie in the

United States will fail from mechanical wear in fifteen years the same as the zinc creosoted tie.

It has never been demonstrated either in this or the foreign countries that the creosoted ties where feeble doses of oil were injected have given good results.

A report by M. V. Harzenstein showing the amount of oil injected per tie, and the average length of life obtained from treated ties on about one-half of the English roads was presented to the International Ry. Congress in 1895. At that time the practice on the various roads was to inject from seven to ten pounds of oil per cubic foot, where ten pounds of oil per cubic foot was injected the life obtained was from sixteen to twenty years, where from seven to eight pounds per cubic foot was injected the average life was from twelve to fifteen years.

The life of the treated tie in the foreign countries is materially increased by the protection given it from mechanical wear.

Since 1895 the English roads have further increased the amount of oil injected per tie, at the present time the practice is to inject from thirty to thirty-five per tie.

The French inject still larger amounts of oil than the English, and obtain better results. In a letter from the Western Ry. of France published by O. Chanute in Bulletin 78 American Ry. Engineers & M. of W. Association, ties on the road treated with from twenty-six to thirty-three pounds of oil per tie failed in twelve years. The present practice consists of injecting 48.4 pounds per tie as a minimum.

Creosoted ties have been sent to this country from England at various times for exhibitive purposes. The dating nail showing that they had been in service twenty to twenty-five years. In no case to my knowledge is the information given as to the amount of oil originally injected. An examination of any of these ties will show that a perfect penetration has been obtained throughout the tie. As the foreign practice on treating ties is to withdraw the air from

the wood before introducing the oil, those familiar with the operation of tie treating plants know that the injection of oil must be pushed to refusal before a thorough penetration is obtained. Therefore it is reasonably sure that these ties originally contained between thirty to sixty pounds of oil per tie, as there are very few woods suitable for treating, where thirty pounds per tie cannot be injected when the air is removed from the wood.

One record of failure where small doses of oil were used took place on the C., B. & Q. Ry. In 1868 and 1869 20,000 creosoted ties were laid on the New Boston Branch of this road and failed in seven years. They were treated by the Seeley process, and contained from three to four pounds of oil per cubic foot. The failure was due to dry rot in the interior of the tie, the ouside of the tie being sound. This treatment failed also on the Chicago, Rock Island & Pacific Ry. That a very good penetration was obtained by the Seeley process was demonstrated at the St. Louis Fair by a similar process.

Red and black oak ties will decay in the center first in most all cases, for this reason it is necessary that the anticeptic solutions should be thoroughly distributed throughout the tie. Where chloride of zinc or zinc creoste are used this can be accomplished at a reasonable cost, but where creosote oil is used the cost will be large if a thorough penetration is obtained, if a thorough penetration is not obtained in creosoting oak ties then either the Burnettized or the zinc creosoted tie will give better results.

It has been suggested that the creosote be injected without first removing the air from the wood, and afterwards the surplus oil withdrawn from the wood by means of the vacuum pump. A thorough penetration can be obtained in this way only where ties are exceptionally well seasoned, but where they are well seasoned they refuse to give up but a very small portion of the oil injected, where the vacuum is afterwards applied.

Von Schrenk—1902:

"This is a red oak tie into which the tar oil has penetrated very nicely into the heart of the tie, as it has also in the next one. By using a special kind of tar oil, one of the same specific gravity as the zinc chloride solution, the process is without question very much superior to the zinc-chloride treatment, but it is still in its infancy.

Here is another, red oak (fig. 18). You see the tar oil and zinc chloride have penetrated to the heart. These photographs were made from middle section of the tie.

Here is a very good one showing the same thing. Here the tar oil has penetrated for a considerable distance. This treatment will probably make these ties last longer than zinc chloride alone, because it will prevent the reaching out of the salts."

These ties are treated by the Chicago Tie Preserving Co.

CHICAGO, Jan. 7, 1906.

Mr. T. W. Calvert, C. E.,
Chief Engineer, C., B. & Q. Ry., Chicago.

DEAR SIR: The ties mentioned in the letter enclosed of Robt. J. McClure were treated by the Seely process and contained from three to four pounds of creosote oil per cu. ft. They also failed on the C., R. I. & P. Ry. in about the same time as on the C., B. & Q. Yours truly,

J. B. CARD.

CHICAGO BURLINGTON & QUINCY RY. CO., CHIEF ENGINEER'S OFFICE.

CHICAGO, Aug. 28, 1882.

O. Chanute, Esq., C. E.

DEAR SIR: In answer to inquiry concerning the preservation of timber I have from Mr. Bislet that 20,000 creosoted hemlock ties were laid on the New Boston Branch of the C., B. & Q. Ry., in 1868 and

'69. These were all taken out before they had been in the track seven years. A hard shell from one-half inch to three-fourths inch in thickness was formed, but the interior crumbled from dry rot.

A tank of iron was put up at Aurora in 1870, and ties and plank were treated with creosote. These ties lasted about the same time as those on the New Boston Branch, but the plank which was used in car floors and in platforms was removed after a few months on account of injury to merchandise coming in contact with it.

I regret that I cannot give you details of the process of treatment.

The men say that the liquid was boiled, but that an attempt was made at producing a vacuum or partial vacuum in the tank before the admission of the liquid. They do not remember the proportion of creosote to each tie. Yours truly,

(Signed) ROBT. J. MCCLURE.

STEAMING TIMBER BEFORE IMPREGNATING.

I quote from letter of A. A. Robinson, President Mexican Central Railroad, April 19th:

"From the very nature of the case, it seems to me that the idea that the ties must be seasoned is fallacious for the reason that the chief point in securing good treatment is to draw from the timber the juices, saps and acids contained in the wood, and it seems to me this can be more rapidly done before they are dried out and while they are in their liquid state."

I think that the observation of many experienced operators will coincide with me in saying that the steaming is an essential part of the process, not only as to the effect on the timber, extracting the juices and toughening the fiber of the wood and in a general way preparing it to absorb the chemicals whatever they may be. While dry ties may be desirable, in practice dry ties or ties of uniform dryness can

rarely be secured. Three hours of steaming at twenty pounds pressure will not injure the fiber and the general condition of the whole charge will be measurably uniform and at the same time in fit condition to absorb the chemical when exposed to it in the retort.

When the steam is discharged and the vacuum drawn the timber is about as devoid of air as it is possible, the pores being filled with expanded vapor and a remnant of air, possibly, and in much better condition to absorb the solution than it can possibly be when the ties are dry and the vacuum alone is relied upon to extract the air from them. We do not suppose in either case that the air is all withdrawn but we can be assured that the condition of the timber is much more favorable for impregnation when exposed after steaming and vacuum in the former case.

When ties are dry and exposed to the vacuum a considerable amount of air will still remain in the tie and when this is compressed by the forced entrance of the solution it will on removal of the pressure, be again forced to the surface.

Ties thus treated are giving off more or less for many hours after removal from the retort all of which goes to waste, whether chloride, oil or whatsoever.

It is undeniable that steamed timber will bear railwear better and it is also true that some timbers cannot be impregnated without the use of steam.

The following article for the Wood Preservers' Association is deemed worthy of reproduction in this connection. Octave Chanute C. E., is one of the highest authorities on the subject treated, and while the author may differ with him on some minor points, yet the article is all the more valuable, serving as a basis of further investigation.

(Published by permission.)

THE STEAMING OF TIMBER.

By O. Chanute.

Having been asked to prepare a paper upon the Steaming of Timber I think that it is well to begin with a glance at the evolution of that process.

The original method of applying antiseptics for the preservation of wood was by soaking it in solutions, chiefly those of mineral salts, and that was the way in which ship timber for the "Wooden Walls of England" was treated with fair results over a century ago. With the opening of the railway era more expeditious methods were called for and in 1831 Breant, a Frenchman, was the first to force antiseptics into wood by hydraulic pressure. He used a closed, vertical cylinder in which the wood was placed upright on end and pressure was applied with a pump. He indicated, moreover, that better penetration might be obtained by producing a partial vacuum in the cylinder before the admission of the antiseptics. Those which he employed were sulphate of iron, linseed oil, and a mixture of linseed oil and resin.

Burnett patented the injection of chloride of zinc in 1838. He first employed the soaking method but subsequently he used pressure in closed cylinders. Bethel in the same year patented the use of creosote and used the Breant method, but his cylinder was horizontal and he produced a partial vacuum therein ... dmitting the creosote. His apparatus and his ... 'ere substantially the modern ones and have

continued in use to this day, but some difficulties were found when operating upon any but thoroughly seasoned timber and in 1846 Pain introduced the process of previous steaming. His method for the injection of sulphate of iron and sulphate of barium, consisted in:

1st. Steaming fifteen minutes. 2nd. Vacuum for ten minutes. 3rd. Introduction of antiseptic. 4th. Pressure of eight to ten atmospheres, the latter being continued forty to fifty minutes.

This was thought to be a notable improvement, more especially when operating upon imperfectly or half seasoned timber and it rapidly grew in favor.

In 1857 Messrs. Lege and Fleury-Pironnett patented an apparatus for injecting railway ties with sulphate of copper by the steaming-vacuum-pressure process and tried a great many intelligent experiments upon fresh cut, half seasoned and fully seasoned wood of various species, to establish the exact advantage of each step in the process. A commission to examine these results, appointed by the Agricultural Society of Sarte (a French Department), tried further experiments and thus summed up the ascertained advantages of steaming.

"Wood, in seasoning, loses a good deal of weight and yet shrinks but little. The sap ducts lose the evaporated water and their walls become incrusted with the non-volatile portions of the sap, among which is vegetable albumen, constituting the principal cause of decay. The albumen dried at ordinary temperature, hardens into a horn-like substance, but the application of moisture and gentle heat again dissolves it and thus re-establishes the continuity of the sap ducts. It is important to reach this result with the least possible amount of condensed water, so as to leave as many voids as practicable to be permeated by the antiseptic solution. This is best accomplished by steaming at temperatures from 212° to 240° F. for ten minutes to three hours according to the kind and condition of the wood, and by following this up for some ten minutes with as great a vacuum as possible. The steam penetrates and dampens all the

fibers of the wood; it heats and swells it considerably; it carries off, moreover, by a sort of washing, various volatile or soluble substances, and yet it condenses in the wood in such small quantities that the increase in weight is negligible and sometimes more than overbalanced by the weight of the matters extracted."

This, it will be noted, was predicated upon the injection of sulphate of copper. It is believed that steaming before the vacuum was then universally adopted in Europe by all the establishments which injected mineral salts, but those injecting creosote early recognized that the small amount of condensed steam left in the wood resisted to some extent the injection of this oily substance, and the writer believes that the present practice in Europe is not to steam wood intended to be creosoted. In England, the timber, much of which has been rafted, is very thoroughly air seasoned. In France and Germany ties are stacked in open piles for ten or twelve months, during which some sixteen to twenty-five per cent. of the weight is lost and then they are in many cases dessicated further in drying ovens (not dry kilns), during which latter process they lose three or four per cent. more of weight before being transferred warm into the creosoting cylinder. Another method is to boil the ties in hot creosote so as to evaporate the sap and make room for the creosote which is injected by pressure. This is perhaps the best method, laboratory experiments showing that there is still eighteen to twenty per cent. of moisture in so-called thoroughly air seasoned timber.

For wood to be injected with mineral salts steaming is generally resorted to in Europe. These salts being in watery solutions the condensed steam is not objectionable as it merely weakens the solution, which is made a trifle stronger than would otherwise be the case.

In the United States Hayford took out various patents for steaming in 1859-1870, 1872 and 1877

which were hailed as great improvements and went into extensive use even for creosoting. For a time every wood preserver steamed before injection and it is only within the last two or three years that the question has been raised whether better penetration with mineral salts cannot be obtained by omitting steaming altogether.

The writer having tried hundreds of experiments during the first ten or fifteen years of his practice in the injection of mineral salts, believes that whether it is advisable to steam or not to steam depends altogether upon the condition of the wood when it becomes necessary to inject it. The best practice is to season it thoroughly, but customers are generally impatient and urgently require the treated wood for immediate use. So the operator has often the alternative of either incommoding his client or of not doing the best work of which he is capable. He not infrequently unloads timber on the ground at his own expense in order to season it a little more.

Wood structure generally contains 30 to 50 per cent. of cells by volume. In the living tree these cells are filled with sap, and the problem is how to replace this sap with some preservative substance. In rafting a small part is washed out by diffusion and in air seasoning perhaps over one-half of the watery portion of the sap slowly evaporates. It is obvious enough that in order to inject satisfactory amounts of any antiseptic a place for this must be found in the wood, and if the sap cells be filled with sap or with water, it is clearly impossible to fill them with another fluid. To clear the sap cells, therefore, we must produce some motive force inside of the wood. This motive power may consist of steam generated inside of the wood, or it may consist of air which has replaced so much of the watery portion of the sap as has evaporated in seasoning, which air is heated and expanded by steaming.

Proceeding upon this theory the writer tried very many experiments with various species of wood, fresh cut, quarter seasoned, half seasoned or wholly

seasoned, by steaming them various lengths of time, they being weighed in and out at each stage of the operations. He found that where the wood was fresh cut and full of watery sap it required no less than eight hours of steaming at twenty pounds pressure (258°F.) to bring the center of a tie six by eight inches section to the boiling point or 212°F., at which the sap would begin to generate steam so as to drive out some of the watery portion. It is understood that the creosoters who operate upon fresh cut or waterlogged piles are sometimes compelled to steam for twenty-four hours, at more than twenty pounds pressure, in order to clear the wood for injection. In that case it is probably safe to begin the operation with steam as high as thirty pounds pressure (275°F) because the water in the wood which first evaporates protects the fiber from immediate injury, but towards the close of the operation the pressure should not exceed twenty pounds, which has been found the point (258°F.) at which small injury to the strength of the fiber is likely to result.

With half seasoned ties, i. e., air-dried from four to six months, according to the time of the year, the writer ascertained the perhaps surprising fact that more sap could be extracted by one to three hours' steaming than could be gotten out of fresh cut ties by three to five hours of steaming at twenty pounds pressure. Of course there was more of the watery portion of the sap in the fresh cut ties than in those half seasoned, but it could not be extracted satisfactorily without much longer steaming. It was concluded that when the wood was half seasoned some air had flowed in and that this, being moderately hastened by the steaming, expanded so as to drive out a good deal of the remaining sap, and this view was confirmed by the examination of the ties immediately upon their withdrawal from the treating cylinder, when minute bubbles of air and sap were observed issuing from the ends of the ties.

With fully seasoned ties, say six to twelve months from the cutting, the effect of the steaming was some-

times to increase the weight of the ties, and sometimes to diminish it, such increase or loss being, however, very small and well within two per cent. It was found that when the ties were in that condition it was best to dispense with the steaming altogether, and to begin with the vacuum; as more solution (chloride of zinc in this case) could be injected than when the ties were previously steamed, which latter operation, leaving some condensed steam in the wood (say perhaps five per cent. of its weight reduced to two per cent. by the subsequent vacuum), diminished by just so much the quantity of solution which could be forced into the tie.

These experiments were made from 1890 to 1900 and were fully confirmed by experiments made in 1904 by Mr. S. M. Rowe. From the results and from experience gained in regular working, the following practice has grown up at the works of the writer:

1st. To refuse to treat fresh cut ties, but to put them down on the ground to season.

2nd. To begin the spring season's treating by steaming, unless the ties are of the previous year's cutting.

3rd. To omit steaming in the summer and autumn when the ties prove to be well seasoned.

This practice leaves open the question whether it is important for the best results to first sterilize the germs of decay by heat, either that of steam or that of hot air in drying ovens. Some bacteriologists hold that the germs of decay exist in the sap of the wood before it is cut down, and some believe that these germs penetrate into the wood after it is treated. The writer's experience with the results of ties previously steamed or treated without steaming is not sufficient to enable him to adduce any facts bearing on this question, but he believes that the European practice of heating wood in drying ovens just prior to its injection is good and that this may be the next improvement which should be introduced in this country. Be this as it may, he hopes that the members of this association will contribute their experience to the dis-

cussion of this paper, and that the result will be to produce still better work in wood preserving.

CONSERVATION OF FORESTS IN AMERICA.

Prest. J. J. Hill of the Great Northern Railway in speaking of the exhaustion of soil, timber, ores and coal, while presenting a startling possibility in a humanitarian sense, yet in each case there is a large element of truth. That improvidence pervades in the several cases that cannot but mean ruin to civilization in the course of time and not very far distant as measured by human history.

Confining ourselves to the two most imminent sources of peril, that of exhaustion of the soil and the woods, we can look back not beyond the space of the life of our great-grandfathers and view our whole territory from its eastern limit to a line far west of the Mississippi river, now essentially denuded of its forests, and at the same time large inroads are being made in the far west and in the timber centers of the south.

As to the soils, Mr. Hill only repeated what every well informed agriculturist knows. Minnesota and the Dakotas were for many years noted for both the quantity and the excellence of the wheat crop. Now we hear of trouble from rust and other kindred evils; only what should be expected after *taking off and putting nothing on* for the last thirty or forty years. *It means poverty of soil;* soil impoverished by wasteful methods and human greed.

In 1840 Illinois raised just as fine wheat for a few years, then the crop began to fail generally except where the land was fed by its own products such as manure from stock—and by intelligent rotation of crops, and was thus rendered prolific for wheat indefinitely. That this can be done in any and all the agricultural states will hardly be questioned.

The same improvidence seems to be the rule in our forests. The forests of this country are the product of several hundred years previous to its occupation

by our people; some trees now being cut are the natural growth of a thousand years, over thirty generations, and many trees are being cut that cannot be re-grown in ten generations. The remaining supply of timber is being still further imperiled by fires more numerous and destructive from year to year as the country is being invaded and the increased demands of trade, calls for more wood. The amount of timber required for railroad ties alone is such as to tax present supply and to accentuate the exhaustion of our remaining forests. It is not necessary to call for statistics as the ever increasing demand as to this one item of supply and increasing cost will sufficiently attest.

The forces of nature can be depended upon to replace the waste to the extent of the existing area for growth only, but it is constant and persistent and in the aggregate it will go far to repair the loss if given a fair chance. Perhaps the most powerful influence that can be employed to aid is the building up of the sentiment of love for the tree among the masses of our people. This interest is easily awakened and if cultivated will show results after a time. Arbor day if generally kept in the schools of the country will make its influence felt, especially with the young. Tree planting where conditions are right while tending the same way is but puny compared with the forces of nature. We must look to other measures to conserve nature.

Once in a while we come across a *timber lot* or a bit of the original forest in some of the older states where it has been carefully preserved in its primeval state and where we consider that this is what existed over half of the territory now covered by our country, we can better appreciate the destructive forces at work.

Where human greed is unrestrained we see the main cause of unnecessary waste by the reckless destruction of everything, except the tree bodies that are cut into lumber and to which much of the destruction by fire originates and may be attributed.

Another cause of waste consequent on the foregoing manifestation of human greed is in the promiscuous bleeding for turpentine, where premature destruction is carried out on the young and fast growing second growth trees too small to produce much, and causing the trees to blow down thus destroying what in the next generation would produce valuable trees. The thought suggests that tree economy would require that the production of turpentine be confined to that which can be extracted from the matured tree or from the waste part of trees cut into lumber. Just how far the Government can lawfully interpose to avoid this unnecessary waste is something we cannot here say, but it would seem right that such power or influence as it does possess should be exerted to this end.

The Forest Service Bureau of the Department of Agriculture it is presumed is the proper party through which all the powers of the general Government are brought to bear, and to this we must anchor our hope and trust that such influence as they possess joined with the sound sense and far seeing judgment of those engaged in the lumber producing business, will at least partially prevent this almost criminal waste in the future. A proper understanding between this Department and the lumbering interest will go far to prevent destructive fires. The responsibility for carelessness or wanton setting of fire should have heavy penalty attached and should be enforced whenever possible.

Tree Planting: Over sixty years ago, the writer then but a boy, found no greater pleasure than that of roaming the then primeval forest with its growth of noble trees: Oak, Walnut, Hickory, and almost a complete list of those trees of the temperate zone with its concomitant herbage, forming a book, the study of which caused almost a feeling of reverence for those noble trees, and impelled the planting of the Walnut as it dropped from the parent tree. The result of this boyish impulse is a tree eighteen inches in diameter above the stump and this in a situation

not at all favorable to the Walnut. With favorable soil and conditions as to moisture, double this growth would have resulted.

Two trees seem to be adapted in a commercial sense, for profitable planting on account of rapidity of growth; the Black Locust and the Osage Orange (Bois d Arc) especially the latter on account of its freedom from insect attack, a source of almost complete destruction of the locust, which should command attention of our Forest Bureau. Both these trees will grow in almost any soil or situation, producing the most lasting of wood and growing very closely. The Osage Orange, if planted very closely and given close attention during the first five to eight years in trimming away side branches, should produce the highest and earliest return for the ground and the labor expended.

Railroad Cross Ties: The call for railroad ties is one of the most severe drafts on the timber supply and this has been confined thus far to the White Oak, but the time has now arrived when railroad managers are forced to relax and resort to the softer timbers simply because the white oak ties cannot be had. It is apprehended that they will be equally obdurate as to the use of steel for the same purpose as long as wood can be had at almost any price on account of the superiority of wood for this purpose. Even if steel or other substances are adopted, the wood must be interposed in the shape of blocks or shims to ease the rigidity of the bearing of the rail.

Chemical Treatment of Timber: If the softer woods which have heretofore been rejected on account of their shorter life when exposed to the elements in the railroad track can be utilized, the field of supply is infinitely enlarged and much that has heretofore been considered useless and being destroyed can be utilized.

Much has been offered pro and con as to whether the methods of treatment in this country have been successful, but the writer believes that the best

authorities of today as well as future results will justify in saying that many of the woods heretofore rejected can be made to last longer and make better ties than even the white oak.

Wood Pulp: This is another source of depletion of the forest and no doubt a legitimate and useful one, but confined to a few of the most valuable timbers. The thought occurs whether the remnants of other woods may not be utilized instead of the more valuable tree bodies as suggested in the obtaining of turpentine from the pine. These remnants may not be so cheaply reduced but considering that the material will otherwise be wasted, does it not come within the line of policy of the government to forbid further waste?

In view of the fact that all wood fiber is of much the same consistence does not this view seem reasonable?

Tree planting, while as before stated, carried on by human effort now in its infancy, is puny compared with the results of nature, may grow in time to be of much importance. A combined effort by all parties whether individuals or railroad, or other corporations will result eventually in an increase worthy of the effort.

One great advantage will be in the awakening of effort that will increase both interest and knowledge on the part of the people with an increased disposition to not only add to the volume of the product, but to avoid waste and to create a feeling of sacredness toward the noble plants that banish the desert wherever they are grown.

Aside from the conservation of existing forests their reforestation seems to be the most important of all, and efforts in this direction are being stimulated by the aid of the Forest Service under the able direction of that department of the government. There is hardly a doubt but that the vast area of the white pine in Michigan could with proper care have been far along toward this reproduction and that it is not due to the impoverishment of the soil, but is

due to the improvident burning over, and not to any great extent to stock pasturage. In the south where the pines have grown the second growth it is growing vigorously, but the Old Field and the Yellow pine growing vigorously as to defy stock very quickly. Reproduction of forest in this way can of course be aided by extended planting in connection with those growing naturally, the latter furnishing the young plants for resetting in open spaces.

Tree planting on desert or some desert lands seems to be of uncertain utility, we see on the great plains over a stretch of many hundred miles almost treeless with the one exception of the cottonwood, and that only along the streams, even then of but little value except to relieve the eye.

Only long patient study will determine how far it is practicable to encroach on the great plans, and what useful timbers can be grown. The absence of any other timber is strong evidence that it will be difficult to grow other timbers with any degree of success.

But let reforestation be attempted, the original primitive forests of this country can never be reproduced. Human effort directed by the knowledge now being so acquired and prepared by the United States government through the Forest Service can be used to direct the impulses of all possible effort in the most practical methods. Desultory and limited efforts can be utilized with the æsthetic sense, impelled by that innate love of beauty among the people, will only beautify the country.

The commercial spirit can hardly impel extensive tree planting exclusively, because the reward or commercial return is so long coming. We will take a case of the production of one tree, say that of the western yellow pine where it requires 200 years to produce a tree thirty inches in diameter at the stump having a volume of wood equal to 2,000 feet board measure producing 1,200 feet B. M. of sawed lumber. This same tree is one-tenth grown at 70 years, one-third grown at 100 years and three-

quarters grown at 160 years; so we see that the reward is so remote that it is of little interest to people now living. Large corporations managing ten thousand miles of railroad perhaps might enter upon this humanitarian scheme with a remote hope of succeeding in beautifying their property remotely. It is true that some timbers mature or at least become of such size as to be used at a much earlier period, the Catalpa for instance, but this can only be done in the south or on a soil much too valuable to be given over in the face of rapid filling up of the country by the natural increase in population.

In view of this, it would seem proper to first save our forest by ceasing wasteful methods in cutting; second, by increasing available stock by drawing from contiguous countries, inviting rather than repelling trade by too high tariff on importations; or lastly, and not the least, by any means, saving our remaining forests by elaborating the first mentioned means, that of broadening the field for supplying railroad ties and timber by treatment chemically as is now coming somewhat into favor. For ties alone the railroads in the United States call for annually somewhat over sixty million cross ties, 2,160 million feet B. M., leaving out of consideration bridge timber and piles.

By use of preservatives the field is broadened, first by bringing into use many of the less valuable timbers, and secondly by at least doubling the life in service. Until very recently only a few of the most valuable trees were accepted, such as the white oak, cedar, etc., now there is scarcely a wood fibre but may be made as lasting as the best.

I will not say that efforts in tree planting will be in vain. It is a work our government may well take up and should do so, and the progress toward doing it understandingly is such already as to give hope of great good to posterity at least. Its influence will tend to foster the love of the tree among the people, will do more to curb wastefulness among lumbermen and is about the only influence that will do this

effectually. The many millions of forest reservations and their management as well as the extension of the same systematic management to the private preservers with the constant improvement of this service is a hopeful topic on which every one should second heartily.

Reforestation is a matter in which government aid and influence should be exerted as the most practical means to the desired end. Soil and climate have much to do with the success. When the pines have grown they will grow again as in the northmost bounds of the temperate zone for the white pine, on the mountain breast below the snow line for the Fox spruce, etc., and on the alluvial plains of the south for the southern yellow pine and the kindred trees and on the alluvial valley almost everywhere for the walnut, maple, hickory, beach, etc. The lesson taught is where they each grow best there plant them. As nature furnishes the plant this can be done most easily with the best assurance of success.

Statistics have been avoided from paucity of data at hand. The work of the Forest Service will in time give this in a shape not possible by the efforts of the writer. A mass of detail matter has been gathered but it will require much time and labor to make it available.

"Great oaks from little acorns grow; Great rivers from little rivulets flow." This couplet whether rightly quoted, covers in a humanitarian sense, matters of vital interest to the human race. Destroy the tree, and the rivulet dries up and the river becomes a dry desert. The tree is the noblest and most useful of all plants. It is doubtful whether a man ever willingly put his axe into one without a sense of violation of his ideal of life or enjoyment unless impelled with a sense of gain.

When the instinct of gain is present, the forest is ruthlessly invaded with no other thought. Only the interposition of government control will save the country from becoming a desert from total destruc-

tion of the forest and the drying up of the waters.

A natural veneration for this noble plant, the tree, such as will not only deny its destruction but will impel the planting of the tree will aid in ameliorating the conditions. Nature has stored up in advance a bountiful store of forests which inside of 300 years is threatened to become largely depleted in the near future, and it will be indeed fortunate if the unnecessary waste can be arrested before its scarcity reaches acute conditions.

AN ARRAIGNMENT

WESTERN RAILWAY CLUB, MEETING AT AUDITORIUM, CHICAGO, DEC. 16, 1902

From an address by Dr. Herman von Schrenk, in charge of the Missouri Valley Laboratory of the Bureau of Plant Industry of the U. S. Department of Agriculture, we quote:

a. ". . . . and leave out the costly and ruinous steaming process which is generally used in this country." (P. 155 rep.)

b. "I do not go into a discussion as to the value of the glue-tannin treatment to any great extent but I might say I am distinctly opposed to that sort of treatment from the bottom up because it is based theoretically as well as actually, on a great many false factors." (P. 177 rep.)

c. "I believe that a great many railroads will follow the lead of the Atchison road in dropping the zinc chloride glue treatment and reverting to the straight zinc chloride process. (P. 177 rep.)

d. "Mr. Tratman (referring to claim that the glue does not penetrate the wood) "Does that same objection apply to the subsequent creosote process?"

* We want to say right here that any one at all familiar with the process knows that the zinc chloride does penetrate the wood fibre quite completely, more so than any other known solution and that this is not so with the oil which, except in the very soft and open woods, will not penetrate the wood except under very

THIS PARAGRAPH SHOULD GO IN AT STAR, ON OPPOSITE PAGE.]

high pressure and then only penetrating the wood fibre in strips and bands where the high pressure has parted the wood by the radical cleavage and not largely by way of the natural wood ducts.

Mr. von Schrenk: "No sir, that not only penetrates into the holes but completely penetrates the fibre, whereas in the other process it does not penetrate the wood fibre itself, so that I consider the subsequent tannin-glue process a distinct waste of money."

The author has heard this address mentioned but had no opportunity to read it until very recently, and now considers it a duty to notice it and by the light of subsequent developments to weigh its value.

The implication, taking the address as a whole, is that nothing has been done in this country to the advance of the business of timber preservation, of any value.

The position we always assumed in the matter of "Preservation of Timber" is that after the practical benefits of any process have been demonstrated, to hold to it until a better has been proven. Subsequent events indicate that Mr. von Schrenk has followed every new process,—the Barchall, the Alerdyce, the Rueping, and the Rueping reversed, etc., the value of none of which have yet been proven. When their value has been proven we will be only too glad to acknowledge this value.

Answering Mr. von Schrenk's address, we use the quotation as shown at the head of this article in turn.

a. "In regard to steaming timber to prepare for impregnation, we refer to previous articles published herewith. Mr. von Schrenk claimed a year ago 'that steaming reduced the strength of timber twenty-five per cent.* Subsequent careful observations by one of the most careful chemists, Professor Hatt, fail to prove this.

b. "The zinc-tannin which is condemned in toto, is one that has been the means of saving millions of dollars, not only to the A. T. & S. F. Railroad,

*At twenty pounds steam pressure.

NATURAL OILS AS A PRESERVATIVE

Some recent experiments seem to indicate that some of the natural oils, a heavy petroleum carrying a large portion of asphaltum can be used to impregnate ties. According to Mr. Faulkner, of the Santa Fe Railroad Company, that company are proposing to substitute this oil in its crude state, for creosote oil. It has been tested for several years with indications of good results. Should it prove effective it will be most important in the face of early and rapid advance in prices undoubtedly impending.

We have made examination of a Mexican oil of much the same character as the California oil and found its penetration as quite equal to that of the coal tar product. If it holds out as it seems now to promise, the new agent will prove a boon indeed.

The analysis of the San Louis Potosi Oil is as follows:

Color	Dark brown
Odor	Tarry
Consistency	A thick fluid semi-liquid
Appearance	A liquid asphaltic mixture
Reaction	Slightly alkaline
Specific gravity, at $\frac{15^\circ}{15^\circ}$ C.	0.983
Degrees Baume at $\frac{15^\circ}{15^\circ}$ C.	12.4°B.
Viscosity, Redwood's at 21° C.	48,900°
Flashes at	41°C. or 105.8°F.
Burns at	120°C. or 248°F.
Sulphur	3.26 per cent.
Calorific Power, by Calorimeter	14,648. 1 B. T. U.
Weight of 1 gallon of the crude oil	8.1953 lbs.
1 Kilo of oil	1.017 Liters

Distillation of the Crude Oil:—

Begins to condense at	65°C. or 149°F.
First drop over at	74°C. or 167°F.

Distillates Sp. Gr. at $\frac{15^\circ}{15^\circ}$ C. Baume at $\frac{15^\circ}{15^\circ}$ C.

Notes.

By Engler's method of fractioning the crude oil gave as follows:

Naphtha Essences	3.20	per cent.
Illuminating oils	16.50	"
Lubricating oils & paraffins	66.58	"
Coke heated to dryness	13.72	"
	100.	per cent.

Coke as taken from the retort was a black glistening mass.

Analysis of the Coke was found to be as follows: (after burning off all Volatile & Combustible matter)

Fixed Carbon	89.81	per cent.
Ash	10.19	"
	100.	per cent.

Resumé: . . . As a burning oil for fuel this oil could hardly be used to advantage in engines on account of the high viscosity, which would nee extra heating to liquefy the oil to force it to En gine from the tank in which it is kept; on account of the hign sulphur value which would need frequent repairs to the fire box and adjoining parts; and the calorific value is hardly high enough to recommend in the place of coal which is on the market and which gives its equal or better in B. T. U.

The loss by evaporation in 24 hours at 120°F. is 6.22 per cent. The loss will entirely depend on the volume of the oil as well as to the depth of the mass as stowed.

Yours very truly,

(Signed) JAS. M. B. HARD.

TOPEKA, KAN., FEB. 26th, 1907.

Mr. Sam'l M. Rowe, Room 364 Monadnock Block, Chicago, Ill.

DEAR SIR: I have your letter of Feb. 25th, in refer-

ence to the experiments in treatment of ties by crude oil, and beg to say the analysis shows as follows:

Flashes, open test	242° F.
Burns	300° F.
Degrees Baume	15.00
Specific Gravity	.966=60.28 lbs. per cu. ft.
Percentage of Sulphur	2.41
Gasoline	Trace
Illuminating kerosene	22 per cent.
Residuum, (chiefly Asphaltum)	78.00 per cent.
B. T. U.	17,000

In case the same should be of any interest to you, I herewith attach copy of letter which I sent a gentleman the other day, who had been making inquiries in reference to this matter.

Yours very truly,
E. O. FAULKNER,
Mgr. Tie and Timber Dept.

Enc.

We, (The Atchison, Topeka & Santa Fe Railway) have been using crude oil in our engines in California since 1891, and a few years thereafter began sprinkling the roadbed with oil to keep down dust; so that a coating of oil was spread over the tops of the ties, which seemed to add to their life (they were untreated) by keeping the moisture off the tops, at all events this was the belief of the track men.

In the vicinity of Bakersfield in Kern county, California, we get an oil, costing about 25 cents per barrel of 42 gallons, of low gravity, which has an asphaltum residuum of about 77½ per cent., the balance being mainly light oils, so that when Dr. Von Schrenk, of the Government Service, asked our people for a length of track in southeastern Texas to conduct a number of experimental tests on the different wood preservative processes then in common use, we took the opportunity of putting in a few ties of each kind of wood treated with nothing but this same crude oil, alongside the others, in order to ob-

tain a practical comparison of the results. These were treated in the Fall of 1901 and put in the track in March, 1902. Where they are laid an untreated loblolly pine tie lasts about two years, and a long-leaf pine less than four years on account of heat and moisture, so that we use this piece of track for our wood preservative experiments with the surety that if a tie will last from decay down there a certain length of time, it is good for at least three times the life in other places on the System, judging by the life there of similar wood untreated.

The timber experts claim that, in order to produce decay, moisture and heat must be present at the same time, with access to the air. We therefore took thoroughly well air-seasoned ties, in which, of course, the cells would be more or less open, and filled them with this crude oil heated to 180 degrees F., forced in under a pressure of 150 lbs. to the square inch; at this temperature I am inclined to believe that a good proportion of the light oils had evaporated, leaving only the asphaltum residuum, which was then as fluid as creosote. The ties took up from four gallons up to eight gallons per tie, only one taking the latter amount, and the oil appears to have hardened in the cells under atmospheric temperature, so that up to the present (five years' service) they are in first class shape so far as preservation and wear are concerned. In November last we took one out of the track and sawed it in two in the middle and under each rail base; the wood was as sound and firm as when laid in the track, with less rail cutting than with the other treatments, the spike holding firmly, and when drawn was as bright and clean as a newly made one. We have since taken out another pine tie of a different variety, but sawed, and found on sawing it the same as before, that the wood was just as sound and firm. In one place the sawing developed a decayed place in the tie, which had taken up more oil on account of its decay. This had not spread or caused any trouble, presumably on account of the ring of oiled wood surrounding it.

In this experimental track we have a number of different kinds of wood treated with different processes. They all show up well excepting one, (the Hasselman) which has practically gone to pieces; and as a contrast, in each case we also have a number of the untreated woods inserted for comparison. We do not claim there are any antiseptic properties in the crude oil, but we do believe that by stopping up the open wood cells with a substance which solidifies under ordinary temperature, we prevent heat, moisture and air from getting into the wood and thereby affording an opportunity for the decay-producing organisms to begin work. This seems to be proven in our case, and as a result of the test, borne out by general experience on the divisions where oiling has been done; in the new treating plant we are preparing to erect in New Mexico, the pine ties will be treated with this same grade of crude oil forced in under from 150 to 200 lbs. pressure at a temperature of 180 degrees F. We will probably introduce the oil under vacuum, and at the end apply a low vacuum before drawing the ties out of the cylinder, in order that the drip may have a show. By this way the ties are reasonably clean and easily handled after treatment. I am also arranging to put in a lot more in the Texas Experimental track, and sending some to the Tampico Branch of the Mexican Central.

I give herewith a list of the untreated woods which were laid in the track alongside of these oil treated ties in the early spring of 1902, the oil ties being all in first class condition at last inspection (four years and ten months after they were laid), while the untreated ones laid at the same time and all inspected together show up as follows:

196 White Oak Ties.—41 show decay, 3 others have fungus on, balance in good condition.

24 Black Oak Ties.—22 removed 4 years after laying, rotten; 2 still in track, but both show decay.

20 Willow Oak Ties.—15 removed 3 years after treatment, rotten; of the 5 still in track, 1 shows decay, 4 are in good condition.

20 Spanish Oak Ties.—4 removed 3 years after laying, rotten; of the 16 in track, 7 show decay with heavy fungus growth on, the rest in fair condition.

20 Yellow Butt Oak Ties.—18 removed 4½ years after laying, rotten; 2 in track in good condition.

91 Red Oak Ties.—82 removed 3 years after laying, rotten; of the 9 still in track, 7 show decay, 2 in good condition.

49 Tamarack Ties.—All removed 2 years and 9 months after laying, rotten.

100 Loblolly Pine Ties.—All removed 2 years after laying, rotten.

93 Longleaf Pine Ties.—85 removed 2¾ years after laying, rotten; 8 still in track, of which 7 show decay, and 1 in good condition.

100 Shortleaf Pine Ties.—95 taken up 4½ years after laying, rotten; the 1 in track shows decay.

101 Hemlock Ties.—All removed 2½ years after laying, rotten.

100 Beech Ties.—All removed rotten.

(Signed) E. O. Faulkner,
Manager Tie & Timber Dep't.

TREATMENT OF PAVING BLOCKS

As is well known, creosote as a preservative of paving blocks not only increases the life of the wood but also increases its wear under traffic. The addition of a heavier oil or a large percentage of asphaltum added, gives still better results. The asphaltum combines with the oil readily and becomes sufficiently fluid to secure quite complete penetration filling the grain of the wood at the same time increasing its solidity and resistance to the penetration of storm water after laying.

Blocks so treated, laid on a good concrete base makes an ideal pavement, with less noise and jar on the passing of vehicles.

When we compare the various kinds of pavement with its quality for wear, utility and economy, the tendency seems more and more toward the wood.

The primitive cobble stone and granite block we have is undoubtedly the most lasting and most convenient, especially if it is often disturbed for reaching subutilities such as water, gas, etc., as well as affording footing for heavy dray service.

Next in order of utility is a good vitrified brick equally favorable for foothold for draught animals, less lasting but less noisy, the granite in this respect being the most distracting of all, that of the noise caused by the elevated loop being in no way comparable.

Next we have the asphalt laid on concrete footing and no more lasting than the brick, but of such character as to be absolutely unusable at some period of the season.

It seems that a good wood block laid on concrete base should be the ideal pavement, especially if impregnated with Creosote or other good preservative filler.

It would seem from our present knowledge that such a block can be cheaply made, would eliminate the noise, give good footing and be equally sanitary with any other.

THE USE OF S IRONS

We think it worth mentioning that the use of S irons made of thin strips of metal prevents incipient checking or splitting of any timber that is liable to split badly during the drying process. They consist of a rolled strip half inch or so wide to be cut into lengths to grasp sufficient of the wood on each side of the check. Some timbers will split to an extent that renders a tie useless, notably the hickory elm and some other timbers. These should be applied when the check appears early.

A TYPICAL TREE

It is often convenient to have some knowledge of the operation of nature in the production of the tree, especially as to rate of growth in height and volume of wood produced from year to year. Of course each variety will vary so that it is desirable and the only practical way to choose one somewhere near the mean of useful timbers. We therefore select one such for which we find a record of growth each ten years, that of the Northern Yellow Pine and secure a general analysis about as follows:

This table can be used to approximate closely to the actual volume of a 25-foot telegraph pole, a 35-foot pole, a 50-foot pile or the body of the tree.

At "d" we have diameter 4.3 inches, at "f" we have 9 inches and length of 25 feet. Now we add the volumes in Col. "F" (excluding "d"), e = 6.48 cu. ft. and "f" = 9.22. We have volume 15.7 cu. ft.

Similarly "d" to "g" = we have a 38 ft. pole, 11.4" at the butt and containing 28.2 cubic feet.

Similarly a pile 50 feet long, top "e" 6½" dia. and "i", 16" dia. at the large end ("i") we get 42.8 cu. ft. This typical tree contains about 200 cubic or 2400 ft. B. M., but will not afford more than 60% of this in merchantable lumber or 1450 ft. B. M.

Age of Tree Yrs.	Heigh ea. 10 yrs. feet.	Dia. Brst high Ins.	Area. Sq. Ins.	Area. Sq. ft.	Volume ea. Sec.	Incr Ht. ea. 10 yrs.	Ref. letters	Rem.
A.	B.	C.	D.	E.	F.	G.	H.	
10	6	1.0	1.0	.007	.180	5.	b.	
20	12	2.3	4.2	.030	.576	5.	a.	
30	19	4.3	13.9	.095	1.645	9.	d.	
40	29	6.5	33.2	.235	2.350	10.	e.	
50	44	8.9	62.2	.432	6.480	15.	f.	
60	57	11.4	102.1	.709	9.217	13.	g.	
70	69	13.8	149.6	1.040	12.492	12.	h.	
80	79	16.1	203.6	1.414	14.140	10.	i.	
90	87	18.1	257.3	1.786	14.288	8.	j.	
100	94	20.0	314.2	2.182	15.274	7.	k.	
110	99	21.7	369.8	2.568	12.840	5.	l.	
120	104	23.3	426.4	2.961	14.805	5.	m.	
130	108	24.6	476.3	3.307	13.228	4.	n.	
140	112	25.8	522.8	3.636	14.544	4.	o.	
150	115	27.0	572.6	3.976	11.928	3.	p.	
160	118	28.0	615.8	4.276	12.828	3.	q.	
170	121	29.0	664.5	4.589	13.767	3.	r.	
180	123	29.8	692.5	4.843	9.686	2.	s.	
190	125	30.6	735.4	5.107	10.214	2.	t.	
200	127	31.3	769.5	5.343	10.686	2.	u.	
200	127	31.3			201.164	127		
					2414' B.M.			

Chicago Mar. 6th 1907.

Saml. M. Rowe.

WHAT WE HAVE DONE

1885. A. T. & S. F. Ry., Las Vegas, N. M., Operated several years.
1887. Union Pacific R. R., Laramie, Wyo., Plans.
1897. T. T. & L. P. Co., Somerville, Texas, Plans, Supervision and Operation.
1898. Santa Fe Pac., Bellament, Ariz., Plans, Supervision and Operation.
1898. C. & E. I. R. R., Mt. Vernon, Ill., Plans revised for O. Chanute.
1899. Great Northern Ry., Kalispell, Mont., Plans, Supervision and Installation.
1899. B. & M. R. Ry., Edgemont, S. Dak., Plans, Supervision and Installation.
1900. H. C. Sugar Co., Hawaii, Plans with full directions.
1900. Mex. Cent. R. R., Mexico, Consulting Eng'r.
1901. M. K. & T. Ry., Greenville, Texas, Plans, Supervision and Installation.
1901. Alamogorda L. C., Alamogorda, N. M., Plans, Supervision and Installation.
1901. Rocky Mt. Timb. Co., Colo., Plans, Supervision and Installation.
1902. Ayer & Lord Tie Co., Carbondale, Ill., Consulting Eng'r.
1902. Ayer & Lord Tie Co., Grenada, Miss., Consulting Eng'r.
1902. Union Pacific, Portable Plant, Shop Inspection.
1902. O. R. & N. Co., Shop Inspection.
1902. A. T. & S. F., Plans and Specifications.
1903. D. & R. G., Alamosa, Colo., Plans, Specifications and Installation.
1903. C. & N. W., Escanaba, Mich., Plans, Specifications and Installation.
1904. Chihuahua & Pac., Chihuahua, Mex., Plans, Specifications and Installation.
1905. Grasselli Chemical Co., Cleveland, Ohio, Laboratory Plant.
1905. I. C., Southport, La., Creosote, Storage, Plans, Specification and Installation
1905. U. S. Laboratory Plant, Washington, D. C., Plans.
1906. M. K. & T., Greenville, Texas, (Remodeling) Plans and Specifications.
1906. Gray Tie Co., Evansville, Ind., Plans, Specifications and Installation.
1906. C. B. & Q., Galesburg, Ill., Consulting Eng'r.
1907. K. C. T. & T. P. Co., Kansas City, Mo., Plans, Specifications and Installation.

PHYSICAL PROPERTIES OF TIMBER.

In the study of American timbers, especially with reference to treatment, the author has deemed the matter of sufficient importance to give attention to the different phases from time to time as opportunity offered. In the Absorption Tables heretofore published, this study was devoted to the absorptive power of various timbers as specimens could be obtained, as in the operation of impregnation this property was of first importance.

By an inspection of the Absorption Tables "A" to "I" and a comparison with amount of absorption secured in the usual impregnations with a solution like chloride of zinc, with a one or two hours exposure under 100 pounds hydraulic pressure, it is found that as much absorption was secured as would be taken in thirty days by simply immersing in water.

By this means the operator is able to judge the comparative character of any one of the woods. At the time these tables were compiled, the other properties and characteristics were also noted, such as weight per cubic foot, etc.

At this writing, the accumulation of specimens of timber became so numerous that a further effort to enlarge this field of knowledge has been made, covering the strength under compression as a column and in other conditions. These results are given in the subsequent tables "J" to "O" with the former records but covering almost all the wood specimens in reach.

In connection with these tests some further facts are elicited, as to the manner in which timber fails WHEN LOADED TO DESTRUCTION, and also the relative crushing load, both for end pressure, flatwise, and edgewise per square inch.

Plates Nos. I to VI, pages 331-336 are engravings of representative pieces selected from over one thousand test pieces that were tested in the 20,000 lbs. Rielé Press in the Chicago City Laboratory, during June and July of this year, (1908).

THE MANNER IN WHICH TIMBER FAILS UNDER COMPRESSION.

The pieces were uniformly one inch square and four inches long, cut with four inch axis as nearly as possible parallel to the axis of the tree.

The types of failure are indicated in the tables by initials. Thus, P. for Prime, etc.

For the purpose of showing more fully the physical properties of the various woods tested, this series of illustrations are submitted.

The following abbreviations are used in the tables of tests J, K, L, M, N and O, to indicate the character of failure in each case.

Plates No. I and II. (P.)—Prime, with a tendency to shear off on a plane of shear at a regular angle to the axis of the piece.

Plate No. III. (P. S.)—Prime Shattered, that of straight grained wood but easily cloven during test.

Plate No. IV. (P. T.)—Prime Tough, timber of tough pliant fibre.

Plate No. V. (P. C.)—Prime Crumpled, the same as "P" except having been badly checked by high pressure, or other cause for parting the fibre of the timber.

Plate No. VI. (B)—Broomed or Crushed. Number $\frac{33}{2}$ has been crushed down to show more clearly the effect on the fibers of the wood.

This classification is intended to guide in the study of the nature of timber fibre and should be reviewed carefully and given further careful study, as the writer has so far been unable to do for want of time and various other reasons.

It is desired that other investigators express themselves as regards the causes of the various phases of the Phenomena.

ADVANCE SHEET

OF

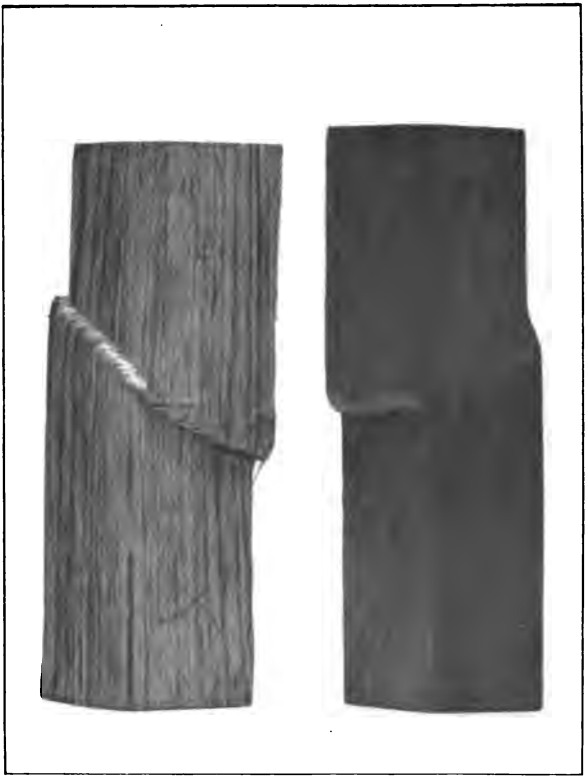
SUPPLEMENT

TO

"Preservation of Timber"

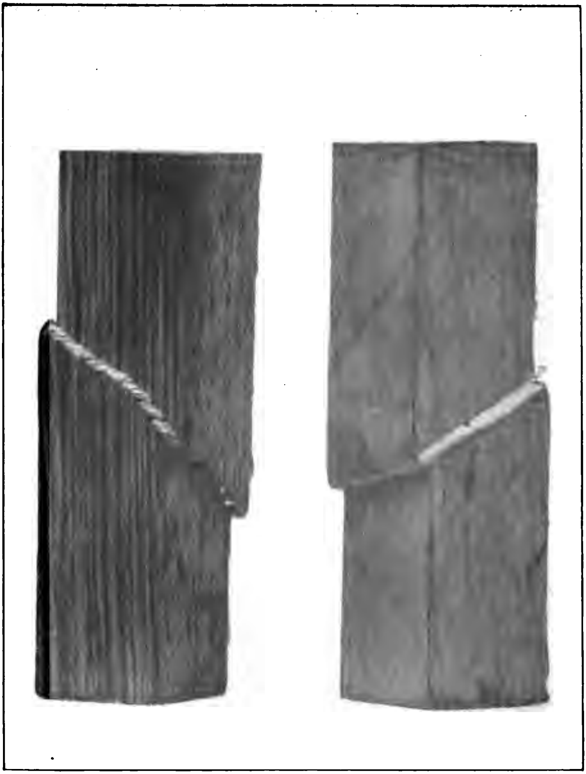
FOR

1909 EDITION



36/9		51/3
UNTREATED SO. YELLOW PINE	PRIME (P.)	TREATED HARD MAPLE

PLATE I



37/5 81/2

PRIME (P.)

PLATE II

$\frac{104L}{8}$ $\frac{104L}{9}$

MEXICAN PINE, UNTREATED
PRIME SHATTERED (P. S.)

PLATE III

$\frac{84}{3}$
HARD MAPLE
UNTREATED.
PRIME TOUGH, (P. T.)

$\frac{18A}{1}$
HICKORY
UNTREATED,
PRIME SHATTERED, (P. S.)

PLATE IV

$\frac{38}{1}$ HARD MAPLE IMP. 500 $\qquad$ $\frac{69}{2}$ HARD MAPLE IMP. 500

PRIME CRUMPLED (C)

PLATE V

$\frac{33}{1}$ $\frac{33}{2}$

SOUTHERN YELLOW PINE PAVING BLOCK
BROOMED (B)

PLATE VI

TABLES OF ABSORBENT PROPERTIES OF TIMBER.

On page 147 "Preservation of Timber" and pages following; Tables A, B, C, D and E, page 181, are given as a record of observation on the character, weight, etc. of timbers obtainable up to January, 1904. Herewith are submitted a series of tables, being a record of timbers more recently examined, giving such further facts as have been gathered, with a view of continuing the record for use in the future.

The compressive strength with a view of comparison between the various timbers is added, as well as some experiments bearing on the amount of solution or oil taken up during treatment, effect of over-pressure, the effect of time and exposure at various times during the life of timber in service, etc.

Table "F" is results of Zinc-Creosote Process on various oaks and other timbers which fully explains itself. The absorption was taken after treating and thoroughly drying the blocks before immersing them in water.

Table "G" is experiments on Run No. 3 where Tar Residium was used instead of Creosote. Weight of timber was taken before treating and again after treating and well drying.

Lower part of table is Hard Maple and Red Oak, treated or untreated as indicated.

Table "H" gives a special test on White Oak Ties, 15 years in service. Nos. 1 to 8 being White Oak laid in sandy soil and surface rotted, and Nos. 9 to 16 being ties 15 years in service laid in moist ground. A little figuring will indicate that the loss to the timber was about in proportion to the amount of wood entirely rotted away, leaving the sound timber almost as good as new.

Table "I" is absorbent properties of various specimens tested as explained on the right hand of the table.

Table "J" commences the series of Ultimate Crushing Loads. The numbers in the left hand column refer to the corresponding numbers in Tables "A" to "E" inclusive. Same is true of Tables "J" to "O."

Tables "K" Nos. 1, 7, 9 and 10 are the White Oak Ties 15 years in service on the South Chicago City R. R. as shown in Table "H" 5,200 lbs. the ultimate crushing load per square inch as against 6,900 pounds per square inch for new White Oak.

Table "L" No. XIX, Table "I" is untreated pine 15 years in track and 12 years in concrete where it shows almost the original strength, 4,200 pounds per square inch and also the strength of the Michigan White Pine treated in 1885, part of the Isleta bridge, carrying near 4,600 pounds per square inch. See also Nos. 102 to 108, various Mexican Pines.

Table "M" explains itself.

Table "N" and "O", effect of over-pressure on the timber fibre. When the treatment of ties by the Wellhouse process in 1885 was commenced, the rule was laid down that no more than one hundred pounds of pressure per square inch should be allowed on the charge while in contact with the solution. This was accepted on the authority of Mr. Wellhouse, Mr. Jos. P. Card and Mr. Chanute and has been the practice with most, using either the Zinc-Tannin or the Burnett process with slight allowable deviation since that time. This was derived from past experience and was accepted as being correct and the general opinion among people doing this kind of work that a pressure much above this would part the timber fibre.

The writer in making some experiments on the possibility of impregnating wooden paving blocks with melted asphalt in combination with creosote oil, found it impossible to make it reach all parts of a four inch block unless a much higher pressure and a high degree of heat was used. In some cases where 300 pounds was applied, the grip of the hand would cause the oil to protrude at the end of the surface of the block long after removal from the retort.

Recently, however, this idea that the higher pressure does so injure the timber has been emphatically denied and the practice among "Creosoters" is to use twice that pressure or more. With a view to aid in correct determination of the question, the writer has gone to some trouble to gather information on the subject. Table "O" given herewith, gives the various timbers and Plate No. VI, page 348, etc. gives the manner in which the timber fails in each case. A study of the result, it is hoped, will speak for itself.

Pressure used in the case of No. 33 is understood to be 180 pounds, those of the others are given in Table "N". Part of the information in list "O" was lost, may be recovered later.

Table "P" is a record of experiments with Hard Maple blocks with reference to impregnating them with Creosote in Run No. 1, and a mixture of Creosote and Asphalt in Run No. 2, giving computations of results.

Table "Q", Run No. 3 and 4, a record of treatment with Creosote, the blocks being unseasoned.

Table "R", record of treatment of various timbers by the Zinc-Creosote process.

Table "S", Philippine Island woods.

Table "T", is a computation of results in impregnating Mexican timbers, both in Metric and American terms. Note the effect of varying time steamed and hydraulic pressure used.

The experiments here recorded required years to compile and hold much that require much more study and elaboration to exhaust the mass of information herein comprised.

ABSORBENT PROPERTIES OF TIMBERS – WEIGHT ETC. (CARD. ZINC-CREOSOTE.) (F.)

Number	Kind of Timb.		Ht. or Sap.	Weight "a" Per Cu" Ozs.	Weight "a" Cu. Ft Lbs.	Spec Gr.	Moist at Com.	Absorption % in Vol. 1 d.	7 ds.	14 ds.	28 ds.	60 ds.	
II.	Red Oak.			.449	48.5	.778		.091	.161	.193	.236	.357	
IV.	Burr "			.492	53.1	.851		.046	.091	.109	.137	.150	
VI.	Black "			.497	53.7	.861		.078	.138	.168	.210	.238	
VIII.	Beech.			.421	45.5	.730		.126	.200	.231	.259	.268	
X.	Pine.			.281	30.4	.487		.056	.120	.147	.177	.201	
XII.	Cypress.			.258	27.9	.447		.112	.206	.241	.292	.321	
"a"	40 days dried.												
I.	Red Oak.			.392	42.3	.679		.126	.163	.194	.228	.292	
III.	Burr "			.487	52.7	.845		.054	.101	.127	.158	.172	
V.	Black "			.511	55.2	.895		.064	.101	.134	.161	.194	
VII.	Beech.			.409	44.2	.709		.205	.259	.282	.309	.325	
IX.	Pine.			.265	28.6	.459		.046	.093	.119	.163	.193	
XI.	Cypress			.285	30.8	.494		.068	.109	.139	.184	.216	

RUN No 1
ZINC-CREOSOTE
OCT. 26TH '07.
20% OIL, 4% ZINC
1 HR VAC. 24"
1 " PRES. 100#
TEMP. 157° F.
STEAMED 1½ HRS

RUN No 2.
ZINC-CREOSOTE
OCT. 30TH '07.
NOT STEAMED.
VAC. 30 MIN. 22"
1 HR. PRES. 100#
TEMP. 150° F.

Saml. M. Rowe.

Number	Kind of Tim.	Wt. Before Tr. Cu. In. Ozs.	Wt. Before Tr. Cu. Ft. Lbs.	Wt. Before Tr. Spec. Gr.	Weight Cu. In. Ozs.	Weight Cu. Ft. Lbs.	Spec. Gr.	Moist at Com.	Absorption in Vol. 1 D.	7 Ds.	14 Ds.	28 Ds.	60 Ds.		Run No. 3.
XIII	PINE	.282	30.5	.489	.289	31.1	.500		.060	.127	.150	.196	.233		ZINC-RESIDUUM.
XIV	"	.285	30.8	.495	.311	33.6	.539		.030	.078	.126	.155	.195		OCT. 30TH 1907.
XV	"	.286	30.9	.496	.311	33.5	.538		.049	.090	.156	.200	.251		14 % RES. 4% ZINC.
XVI	"	.321	34.5	.556	.342	36.9	.593		.065	.128	.152	.181	.214		VAC. 30 MIN. 22"
XVII	OAK. WH.	.411	44.5	.712	.461	49.8	.799		.024	.060	.070	.087	.122		45 MIN. PRES. 100#
XIX	PINE	.288	31.1	.498	.447	48.3	.774		.037	.131	.184	.235	.299		TEMP. SOL. 165°F.
XX	"	.263	28.5	.456	.399	43.1	.691		.044	.157	.207	.380	.396		
															ABSORPTION TEST
					Card	Blocks.									ON HARD MAPLE
		Absorption	Tests		July				6th	1907.					TREATED AND
73	HARD MAPLE	UNSEASON'D		UNT.	.483	52.2	.837		.032	.082	.165	.219	.253		UNTREATED AND
66	" "	"		"	.487	45.2	.739		.051	.119	.251	.273	.338		UNTREATED RED
54	" "	"		I.C.	.408	44.2	.709		.025	.040	.073	.098	.127		OAK IN CONNECTION
80	" "	"		UNT.	.444	47.9	.768		.054	.065	.089	.110	.127		WITH THE CARD
61	" "	"		2.C.	.427	46.1	.739		.020	.040	.083	.117	.128		TESTS. JULY 6TH 07
85	RED OAK	PT. SEASON'D		UNT.	.512	55.3	.887		.087	.156	.176	.202	.234		
88	" "	" "		"	.461	49.8	.801		.046	.097	.129	.160	.194		

Saml. M. Rowe

ABSORBENT PROPERTIES OF TIMBER – WEIGHT ETC. (H)

Number	Kind of Timb.	Wherefrom	Ht or Sap.	Weight: Cu. In. Ozs.	Weight: Cu. Ft. Lbs.	Spec. Gr.	Moist at Com.	Absorption in Vol: 1 D.	7 Ds.	14 Ds.	28 Ds.	60 Ds.	
1	WHITE OAK.	CHI. CITY RY. UNTREATED		.393	42.4	.680		.085	.138	.169	.200	.234	
2	" "	"		.448	48.5	.775		.067	.121	.165	.185	.233	
3	" "	"		.375	40.5	.648		.093	.148	.179	.206	.261	
4	" "	"		.412	44.5	.713		.083	.140	.169	.211	.259	
5	" "	"		.393	42.4	.680		.124	.159	.217	.252	.307	
6	" "	"		.399	43.2	.692		.136	.194	.234	.287	.316	
7	" "	"		.431	46.5	.745		.107	.166	.201	.239	.295	
8	" "	"		.417	45.1	.723		.110	.179	.201	.251	.308	
9	" "	"		.378	40.8	.653		.157	.217	.258	.305	.346	
10	" "	"		.404	43.6	.700		.128	.189	.229	.266	.324	
11	" "	"		.465	50.2	.804		.138	.201	.236	.241	.317	
12	" "	"		.385	41.5	.666		.131	.190	.223	.264	.318	
13	" "	"		.468	50.5	.810		.066	.130	.173	.223	.284	
14	" "	"		.348	37.6	.604		.080	.145	.177	.223	.260	
15	" "	"		.476	51.4	.823		.066	.121	.161	.209	.257	
16	" "	"		.461	49.7	.797		.071	.135	.170	.212	.259	

1 TO 5 W.O. TIE 15 YEARS IN SAND.
6 " 12 " " " " WET SOIL.
13 " 16 " " SEASONED & SOUND.

Saml. M. Rowe.

ABSORBENT PROPERTIES OF TIMBER – WEIGHT ETC. (I.)

NUMBER #	KIND OF TIMB.	WHERE FROM	HT. OR SAP.	WEIGHT. CU. IN. OZS.	WEIGHT. CU. FT. LBS.	SPEC. GR.	MOIST AT COM.	ABSORPTION IN VOL. 1 D.	7 Ds.	14 Ds.	28 Ds.	60 Ds.
17	Y. PINE BLOCK	INDUPL'S TREATED		.582	62.9	1.00		.051	.090	.101	.128	.152
18	PINE TIE.	UNTREATED		.254	27.5	.440		.123	.195	.242	.279	.301
19	" "	"		"	"	"		"	"	"	"	"
20	RED OAK.	GREENVILLE		.402	43.4	.696		.132	.240	.292	.337	.399
21	" "	"		.387	41.7	.669		.125	.239	.293	.341	.381
22	WHITE "	CHI. CITY RY		.418	45.2	.724		.138	.219	.226	.291	.331
23	" "	"		.487	52.6	.843		.131	.210	.250	.290	.343
24	RED "	GREENVILLE		.480	45.4	.729		.079	.162	.187	.245	.334
25	" "	" XX.		.440	47.5	.762		.091	.164	.198	.231	.346
26	" "	" XXX.		.383	41.3	.663		.104	.206	.279	.296	.390
27	" "	" XXXX		.445	48.0	.770		.046	.088	.110	.175	.196
28	" "	LOW'Y "		.467	50.0	.808		.044	.088	.115	.176	.198
84	SUG. MAPLE	UNTREATED		.407	43.8	.703		.082	.163	.209	.253	.276
59	" "	TREATED		.467	50.5	.810		.015	.043	.077	.091	.140

18-19 PINE TIE LAID IN CONCRETE 15 YEARS.
20-21 SOUND RED OAK.
22-23 GREEN WHITE OAK.
24 RED OAK
25 CREOSOTED TWICE LOW'Y & RUEP.
26 " " LOWRY.
27 " " & RUEP.
28 " " (SAMPLE)
84 SUGAR MAPLE UNTREATED
59 " TREATED (CARD #2)

Saml. M. Rowe.

CONSOLIDATED STATEMENT OF WEIGHTS, ABSORPTION, ULT. CRUSHING STRENGTHS, ETC.

NO.	NAME	WHERE FROM	HT. SAP.	WEIGHT. OZS. CU. IN.	WEIGHT. LBS. CU. FT.	SP. GR.	ABS. 30 DAYS. % IN VOL.	ULT. CRUSHING LOAD. AS COL'N	ULT. CRUSHING LOAD. FLAT	ULT. CRUSHING LOAD. ON EDGE	ULT. CRUSHING LOAD. DIAG.	ABBREVIATION	"J." REMARKS.
44	ASH, WHITE	C&N.W.R.R.						6282		915		P.T.	
79 E.	" "	BARBER.	HT.	.350	37.8	.606	.290	6060			1089	" "	
40	" BLACK	C&N.W.R.R.						3830			625	C.	
58 D.	BEECH	O.CHANUTE	HT.	.358	38.7	.621	.248	6351			1180	P.S.	
29	BIRCH, YELLOW	C&N.W.R.R.		.359	38.6	.621	.339	6022			906	B.	
31	" WHITE	" " " " "		.346	37.4	.599	.2503	5774	1033	1066		P.T.	
44 C.	CEDAR, "	G.N.R.R.	B'TH	.200	21.6	.347	.357	3503	500	605		P.S.	
4 A.	"	O. BATES	SAP.	.160	17.9	.288	.263	2315	507	500		P.	
3 A.	"	" "	HT.	.204	22.1	.354	.274	3697	600	550		P.	
66 D.	COTTONWOOD.	G.N.R.R.	HT.	.288	24.6	.334	.383	3839	475	425		P.	
83 E.	CHERRY, WILD	BARBER.	HT.	.420	45.4	.728	.170	5280	1275	1275		P.	
X1 F.	CYPRESS.	CARD		.285	30.8	.494	.184	3594			490	P.	ZINC-CREOSOTE NOT STEAMED
42	ELM, ROCK.	C&N.W.R.R.						5014	1090			C.	
100 E.	" "	" " " "	B'TH	.440	46.9	.756	.216	6149	1615	1712		P.T.	
84 E.	" RED	BARBER	HT.	.307	33.1	.532	.215	6313	1072			P.T.	
47	" WATER.	C&N.W.R.R.						3854	1660	1130		P.T.	
71 D.	FIR, DOUGLAS	G.N.R.R.	HT.	.291	31.4	.504	.229	5471	850	1157		P.S.	
11 A.	" "	C.M.&ST.P.	HT.	.304	32.8	.527	.228	5942	705	1300		P.S.	
12 A.	" "	" " " "	SAP.	.309	33.4	.524	.241	6900	637	900		P.	
57 D.	GUM	M.K.&T.RY.	B'TH	.304	32.8	.527	.254	5090	1125	1070			

Chicago Aug. 5th 1908. Paul M. Rowe.

CONSOLIDATED STATEMENT OF WEIGHTS, ABSORPTION, ULT. CRUSHING STRENGTHS ETC.

				WEIGHT.			ABS. 30 DAYS	ULT. CRUSHING LOAD					"K."
NO.	NAME.	WHERE FROM	HT. SAP.	OZS. CU. IN.	LBS. CU. FT.	SP. GR.	% IN VOL.	AS COLM.	FLAT.	ON EDGE	DIAG.	ABBREVIATION	REMARKS.
13 A.	HEMLOCK	C.M.&ST.P.	HT.	.247	26.7	.428	.374	4287	780	607		P.S.	
17 A.	HICKORY, S.B.	" " " "	HT.	.455	49.2	.785	.137	10577	1700	1700		P.S.	
18 B.	" "	" " " "	SAP.	.399	43.0	.691	.190	7885	2335	2062		P.S.●	
92 F.	LINN.	BARBER	HT.	.253	27.3	.458	.256	3980		770		F.	
51	MAPLE, HARD.	J.B.CARD		.426	46.0	.738		5506	2125	1300		F.●	CREOSOTE
69	" "	" "		.461	49.8	.797		6380	1707	1395		P.T.●	CREOSOTE.
39	" "	" "						6222	1140	1430		P.T.	
81	" "	" "						7887	1897	1280		C.●	
65 D.	OAK. WATER.	O.CHANUTE	B'TH	.435	46.9	.754	.132	6241	1010	1435		P.T.	
23 E.	" WHITE.	C.CITY RY.	"	.487	52.6	.843	.290	6910	1750	1525		P.T.	GREEN.
1 H.	" "	So.C.C.RY.	"	.393	42.4	.680	.200	4417	1462	1447		P.T.	15 YEARS SER. IN SAND.
7 H.	" "	" " "	"	.431	46.5	.745	.239	5339	1167	1165		P.T.	
9 H.	" "	" " "	"	.378	40.8	.653	.305	5938	1367	1205		P.T.	15 YEARS SER. IN WET SOIL.
10 H.	" "	" " "	"	.404	43.6	.700	.266	5111	1550	1540		P.T.	
II. F.	" RED	J.B.CARD	"	.449	48.5	.778	.236	6228	1071	960		P.T.	ZINC-CREOSOTE STEAMED
III F.	" BURR	" "	"	.487	52.7	.848	.158	5176			1500	P.T.	ZINC-CREOSOTE NOT STEAMED
VI. F.	" BLACK	" "	"	.497	53.7	.861	.210	5684			1700	P.T.	ZINC-CREOSOTE STEAMED.
15 A.	" RED	C.M.&ST.P.	HT.	.318	33.3	.550	.144	6477	1045	1207		P.T.	
16 A.	" "	J.N.BARR.	SAP.	.307	33.2	.532	.113	5914			1025	P.T.	
Sp'l.	SAFFRON ?							9455	4500			P.S.	VERY HARD AND BRITTLE.

Chicago. Aug 5th 1906. Saml. M. Rowe.

● SHOWN ON PLATES.

Consolidated Statement of Weights, Absorption, Ult. Crushing Strengths, Etc.

"L."

No.	Name.	Where from.	Ht. Sap.	Weight. Ozs. Cu. In.	Weight. Lbs. Cu. Ft.	Sp. Gr.	Abs. 30 Days % in Vol.	Ult. Crushing Load. As Col'm	Flat.	On Edge.	Diag.	Abbreviation	Remarks.
41B	Pine, White.	G. N. Ry.	Ht.	.298	26.2	.420	.213	5399	645	902		P. S	
39B	" "	Colorado	"	.217	23.4	.374	.281	4283	575	572		P. S.	
44A	" Loblolly.	Texas.	B'th	.259	27.9	.511	.508	5114	610	1250		P. S.	
69D	" Bull.	Montana.	Ht.	.245	26.5	.425	.220	4130	730	895		P. S	
19I	" Tie.	N. Mexico.	"	.254	27.5	.440	.279	4156	560	725		P. S.	Untreated laid in concrete [illegible] years.
36	" So. Yellow.	S. M. R.	"					4534	797	1313		P. ●	
37	" " "		"					6199	760	1025		P. ●	
IX F.	" White	J. B. Card	"	.265	28.6	.459	.163	5938	1367	1205			Zinc-creosote not steamed
XIX I	" 15 years in track.	G. Weston.	Ht.	.254	27.5	.440	.279	4166	560	726			Untreated laid in concrete 15 years.
102E	" Tras Marius	Mexico.	B'th	.254	27.5	.440	.276*	4174	412	400		P. S.	
103E	" Lacheria.	"	"	.249	27.0	.437	.340*	4372	920	750		P. S.	
104E	" Celaya.	"	"	.265	28.0	.459	.272*	4757	704	1075		P. S ●	
105E	" Tinguindin Yurecuara	"	"	.270	29.1	.467	.300*	4880	967	800		P. S	
106E	" "	"	"	.360	38.9	.624	.291*	5934	1137	1987		P. S	
107E	" Oyamel R Celaya	"	"	.278	30.0	.481	.283*	5074	412	827		P. S.	
108E	" "	"	"	.251	27.1	.434	.325*	4298	537	542		P. S.	
33B	" White	Isleta	Ht.	.235	25.3	.407	.210	4526	572	535		P. S	Zinc-tannin process
34B	" "	Bridge.	"	.229	24.7	.396	.272	4616	537	605		P. S	Over 12 yrs. service
20B	"	Bl. Hills	Ht.	.276	29.7	.476	.204	6120			612	P.	
28B	"	" "	Sap.	.266	28.7	.461	.265	4954	842	737		P.	

* 14 days
● Shown on plates.

Chicago Aug. 5th 1908. Saml. M. Rowe.

Consolidated Statement of Weights, Absorption, Ult. Crushing Strengths Etc.

				Weight			Abs. 30 days	Ult. Crushing Load					"M."
No.	Name	Wherefrom	Ht. Sap.	Ozs. Cu. In.	Lbs. Cu. Ft.	Sp. Gr.	% in Vol.	As Col'm	Flat	On Edge	Diag.	Abbreviation	Remarks
21 B	Pine, Bl. Hills.	So. Dakota Wyoming	Sap	.248	26.8	.430	.201	4544	750	942		P.	
22 C	" " "	"	Ht	.252	27.2	.437	.246	5420	680	960		P.S	
25 B	" Mountain	Maxwell Grant.	"	.287	31.0	.497	.217	5820	750	882		"	
38 D	" Colorado	C. N. D.	"	.196	21.2	.340	.299	4299	884	964		P.	
60 D	" N. M.	Old Tie	B'th	.266	28.7	.461	.469	5227	967	770		P.S.	1885 Tie. Zinc-Tannin Process 13 years ser.
60 D	" " "	" "	Sap	"	"	"	"	3981	630	642		"	
26 B	" " "	Maxwell Grant.	Ht	.241	26.0	.417	.239	4643	750	732		P	
42 C	" Norway	Montana	B'th	.237	25.6	.410	.241	4246	500	685		P.S	
46 C	Fir, Oregon.	"	B'th	.262	27.2	.434	.212	3884	642	717		"	
37 B	Pine, Piñon	Colorado	"	.230	24.8	.398	.324	5664	992	1242		P.	
67 D	Spruce, White	Montana	Ht	.133	20.8	.334	.250	3826	400	525		P.S.	
40 B	" "	Colorado	"	.231	24.9	.400	.268	3614	645	600		P.	
47 C	" "	Michigan	B'th	.248	26.8	.430	.236*	5133	575			"	
35 B	" Red	Colorado	"	.260	28.1	.451	.274	4467	1200	1235		P.S	
36 B	" "	"	"	.272	29.3	.471	.248	6751	1062	1040		"	
31 B	" White	N. Mexico	Ht.	.290	31.3	.502	.164	5664	992	1242		"	
81 E	Sycamore.	Barber	"	.379	41.0	.657	.366	6315			1050	P.	
68 D	Tamarack	Montana	"	.241	26.0	.417	.211	5423	852	762		B.	
48 C	"	"	B'th	.273	29.6	.474	.230*	4634	424	584		P.S	
70 A	"	"	Ht.	.293	31.6	.507	.233	6656	812	990		"	

* 14 days.
⊚ Shown on plates.

Chicago, Aug. 5th 1908. Paul M. Rowe.

Consolidated Statement of Weights, Absorption, Ult. Crushing Strengths, etc.

			Weight.				Abs. 30 Days	Ult. Crushing Load				"N"	
No.	Name	Wherefrom	Wt. Sap.	Ozs. Cu. In.	Lbs. Cu. Ft.	Sp. Gr.	% in Vol.	As Col'n	Flat	On Edge	Diag.	Abbreviation	Remarks.
33	Pine, So. Yellow	Indianapolis		.5858	63.27	1.014	.0990	6122	710	887		B. ⊕	Pav. Block Trt'd. Creosote
51	Maple, Hard	Card		.5791	62.54	1.0027		5506	2135	1300		P. ⊕	20# Creosote. 100# Pres.
69	" "	"		.6155	66.48	1.0658		6380	1707	1395		P.	16# Creosote. 100# Pres.
81	" "	"				●		7887	1897	1280		P. ⊕	Untreated.
36	Pine, So. Yellow	S.M.R.						4534	797	1313		P. ⊕	"
37	" " "	" " "						6199	760	1025		P. ⊕	"
38	Maple, Hard	C.&N.W.Ry.						5236				C. ⊕	Zinc-Creo. 500# Pres.
69	" "	Card.						6070				C. ⊕	Creosote. 500# Pres.
84	" "	"						5618				P.S. ⊕	Untreated 500# Pres.
													"O"
I.	Chestnut	Angier.						3727	645	616		P.	Untreated
II.	Hackberry	"						4224	1335	1195		C.	"
III.	Poplar.	"						3111	650	995		P.S.	"
IV.	Willow.	"						2771	400	325		P.S.	"
46c.	Fir, Oregon	Santa Fe Ry.		.2620	27.19	.4340	.2120	3884	642	717		P.S.	

● Shown on plate

Chicago, Aug 5th 1908. Paul M. Rowe.

RECORD OF TREATED PAVING BLOCKS

July 3rd 1907.

RUN No 1, CREOSOTE.								WEIGHT UNTREATED		WEIGHT TREATED		"P"
No	KIND	COND'T'N	VOLUME CU. IN.	WT. BEFORE	WT. AFTER	GAIN OZS.	ABS. % IN VOL.	CU. FT.	SP. GR.	CU. FT.	SP. GR.	REMARKS
50	HARD MAPLE	DRY	130.38	55.250	76.000	20.750	26.10	45.77	.7338	62.95	1.0009	
51	" "	"	130.38	55.625	75.500	19.875	24.95	46.07	.7387	62.54	1.0027	CREOSOTE
52	" "	"	131.18	57.625	79.250	21.675	27.00	47.44	.7607	65.24	1.0461	SP. GR. = 1.0573
53	" "	"	132.03	56.000	76.375	20.375	25.26	45.80	.7343	62.47	1.0013	NOT STEAMED
54	" "	"	129.58	53.000	75.625	22.625	28.59	44.26	.7096	63.03	1.0105	VACUUM = 22"
55	" "	"	132.03	56.500	77.000	20.500	25.42	46.22	.7410	63.80	1.0230	100# PRESS.
56	" "	"	129.70	55.625	74.500	18.875	23.83	46.33	.7428	63.70	1.0213	TEMP. OIL 190°
57	" "	"	131.32	55.500	75.375	19.875	24.80	45.68	.7323	62.12	.9959	
MEANS & TOTALS.			1046.60	445.125	609.625	20.562	25.74	45.94	.7366	63.23	1.0127	
RUN No 2 CREOSOTE & ASPHALT.												
58	HARD MAPLE	DRY	143.91	55.500	63.000	7.500	9.52	41.65	.6678	47.28	.7579	
59	" "	"	131.18	56.375	64.625	8.250	10.48	46.41	.7268	53.21	.8531	CREO. & ASPHALT
60	" "	"	128.80	54.375	61.750	7.375	9.54	45.59	.7310	50.82	.8148	SP. GR. = 1.0322
61	" "	"	131.22	56.000	63.625	7.625	9.76	46.09	.7390	52.37	.8431	NOT STEAMED
62	" "	"	129.56	53.750	61.250	7.500	9.65	44.80	.7183	51.05	.8186	VACUUM 22"
63	" "	"	125.70	55.750	63.375	7.625	10.11	47.89	.7682	54.36	.8715	100# PRESS.
64	" "	"	131.98	56.375	61.250	4.875	6.15	46.13	.7396	50.13	.8038	TEMP. MIX. 135°
65	" "	"	131.98	54.000	63.000	9.000	11.36	44.18	.7084	51.55	.8265	
MEANS & TOTALS.			1054.27	442.125	501.875	59.750	9.94	45.34	.7269	51.85	.8233	

Saml. M. Rowe.

RECORD OF TREATED PAVING BLOCKS.

JULY 6th & 12th 1907.

No.	KIND	COND'N	VOLUME CU. IN.	WT. BEFORE	WT. AFTER	GAIN OZS.	ABS. % IN VOL.	WEIGHT UNTREATED LBS. CU. FT.	WEIGHT UNTREATED SP. GR.	WEIGHT TREATED LBS. CU. FT.	WEIGHT TREATED SP. GR.	"Q" REMARKS.
RUN No. 3 CREOSOTE.												
68	HARD MAPLE	GREEN	135.52	61.125	83.750	22.625	27.34	48.71	.7810	66.74	1.0701	
69	" "	"	129.36	59.625	79.625	20.000	25.33	49.78	.7976	66.48	1.0658	CREOSOTE.
70	" "	"	129.36	58.375	76.125	17.750	22.47	48.74	.7866	63.66	1.0199	SP.GR. 1.0573
71	" "	"	129.36	60.125	78.500	18.375	23.25	50.20	.8065	65.54	1.0509	STEAMED ½ HRS
76	" "	"	129.73	65.625	81.750	16.125	20.36	54.63	.8759	68.05	1.0910	VACUUM 25"
80	" "	"	135.52	60.125	82.250	22.125	26.73	47.92	.7682	65.56	1.0492	100# PRESS.
83	" "	"	129.36	61.625	79.125	17.500	22.15	51.45	.8248	66.06	1.0591	TEMP. OIL. 190°
MEANS & TOTALS			918.21	425.625	561.125	19.214	23.96	50.20	.8058	65.73	1.0578	
RUN No. 4. CREOSOTE.												
72	HARD MAPLE	GREEN	135.52	63.125	83.375	20.250	24.47	50.30	.8065	66.44	1.0608	
74	" "	"	129.36	60.250	79.875	17.375	22.00	50.30	.8065	66.06	1.0592	RUN No. 4
75	" "	"	129.36	61.000	79.000	18.000	22.01	50.93	.8165	65.96	1.0575	SAME AS RUN
77	" "	"	129.36	59.250	76.625	20.475	25.92	49.47	.7948	66.48	1.0658	No. 3.
78	" "	"	129.36	61.500	79.000	17.500	22.15	51.35	.8232	65.96	1.0402	
79	" "	"	132.44	59.375	77.500	18.125	22.41	49.23	.7897	63.20	1.0133	
82	" "	"	129.86	64.125	80.000	15.875	20.02	51.53	.8262	66.79	1.0708	
MEANS & TOTALS.			914.76	428.625	558.375	18.230	22.59	50.44	.8090	65.84	1.0525	
86	RED OAK.	DRY	86.40	41.125	54.500	14.375	27.24	51.41	.8242	68.13	1.0907	INCLUDED IN
87	" "	"	89.40	44.125	55.000	10.875	20.00	53.30	.8547	66.44	1.0653	RUN No. 4.
MEANS & TOTALS			175.80	85.250	109.500	12.625	23.62	52.35	.8394	67.28	1.0780	

Paul M. Rowe.

RECORD OF TREATED BLOCKS
SEE TABLES "F" & "G"

"R."

Nº	Kind	Cond'n	Volume cu. in.	Wt. before	Wt. after	Soln. abs.	Under pressure: Abs. % in Vol.	Weight untreated: Cu. Ft.	Weight untreated: Sp. Gr.	Weight treated: Cu. Ft.	Weight treated: Sp. Gr.	* By immersion 30 days: Abs. % in Vol.	Remarks
RUN Nº 1. "CARD PROCESS" Oct. 26th 1907.													
II.	OAK, RED	DRY	167.25	89.500	112.50	23.000	.2380	57.80	.9266	72.63	1.1646	.2361	ZINC-CREOSOTE
IV.	" BURR	"	196.77	105.625	117.50	11.875	.1070	57.37	.9295	64.48	1.0339	.1372	CREOSOTE 20%
VI.	" BLACK	"	177.09	96.000	118.12	22.125	.2163	58.54	.9387	72.10	1.1560	.2099	ZINC 4%
VIII.	BEECH	"	167.25	78.750	109.50	30.750	.3183	50.85	.8152	70.72	1.1337	.2593	STEAMED
X.	PINE.	"	196.77	58.500	88.50	30.500	.2684	32.11	.5143	48.57	.7788	.1769	VACUUM 24"
XII.	CYPRESS	"	181.02	59.500	107.50	48.000	.4591	35.30	.5674	64.13	1.0283	.2925	100# PRESSURE
MEANS & TOTALS			1086.15	487.875	653.62	165.750	.2678	48.79	.7819	65.44	1.0492	.2126	TEMP. EMULSION 157°
RUN Nº 2. "CARD PROCESS" Oct. 30th 1907													
I.	OAK, RED	DRY	169.29	89.500	108.12	18.625	.1857	57.13	.9162	69.00	1.1063	.2282	ZINC-CREOSOTE
III.	" BURR	"	186.91	101.250	109.00	7.750	.0699	57.92	.9287	62.98	1.0098	.1577	CREOSOTE 20%
V.	" BLACK	"	175.11	99.750	114.00	14.250	.1373	61.53	.9865	70.31	1.1273	.1612	ZINC 4%
VII.	BEECH	"	149.82	69.125	93.62	24.500	.2746	49.94	.8007	67.64	1.0845	.3092	NOT STEAMED
IX.	PINE.	"	188.88	51.750	73.25	21.500	.1920	29.55	.4737	41.88	.6715	.1639	VACUUM 23"
XI.	CYPRESS	"	173.14	45.875	90.90	44.125	.4900	28.61	.4587	56.14	.9001	.1842	100# PRESSURE
MEANS & TOTALS			1043.78	457.250	588.00	130.750	.2149	47.47	.7607	61.32	.9832	.2006	TEMP. EMULSION 150°
RUN Nº 3 ZINC-RESIDIUM Oct. 30th 1907.													
XIII.	PINE	DRY	88.537	25.000	43.250	18.250	.3479	30.50	.4888	52.75	.8457	.1961	ZINC-RESIDIUM.
XIV.	"	"	76.732	21.875	35.375	13.500	.2969	30.79	.4932	51.88	.8318	.1556	RESIDIUM 14%
XV.	"	"	90.525	25.875	45.000	19.125	.3565	30.93	.4960	53.48	.8575	.2005	ZINC 3%
XVI.	"	"	179.098	57.500	95.625	38.175	.3592	46.84	.5561	57.67	.9248	.1812	NOT STEAMED
XVII.	OAK.	"	86.570	35.625	50.625	15.050	.2933	44.44	.7125	62.99	1.0100	.0871	VACUUM 22"
XIX.	PINE	"	66.895	17.250	32.500	14.250	.3593	31.08	.4983	52.46	.8412	.2350	100# PRESSURE
XX.	"	"	68.862	18.125	33.750	15.625	.3899	28.43	.4557	52.93	.8486	.3003	TEMP. EMULSION 165°
MEANS & TOTALS			657.142	203.250	336.125	132.875	.3423	34.72	.5289	54.88	.8799	.2393	

* BLOCKS DRIED BEFORE IMMERSION

Paul C. M. Rowe.

MEXICAN CENTRAL RY.

COMPARISON OF RESULTS — 5 AND 2½ HOURS STEAMING. "T."

STEAMED.	WEIGHT BEFORE STEAMING KGMS.	WEIGHT AFTER VACUUM	WEIGHT AFTER TREATMENT	INCREASE IN WEIGHT	PER CENT OF INCREASE	TIME IN CHLORIDE SOLUTION HRS.	PRESSURE PER SQ. INCH	KGMS OF PURE ZN.CL. ABSORBED PER CU. METER	REMARKS
5 HRS.	1438	1420	2526	1088	76.6	1.90	100	5.246	RUN 123 CYL. 1
" "	1461	1492	3008	1547	105.8	"	"	"	" " " "
" "	1444	1409	2330	886	61.4	0.55	35	4.627	" 124 " 3
" "	1471	1508	2262	791	53.8	"	"	"	" " " "
2½ HRS.	1357	1390	2071	714	52.6	1.95	100	4.888	RUN 125 CYL. 3
" "	1467	1492	3144	1677	114.3	"	"	"	" " " "
" "	1422	1456	2390	968	68.1	1.90	"	5.162	" 126 " 3
" "	1779	1816	3160	1381	77.6	"	"	"	" " " "
							Saml. M. Rowe		

CONVERTED TO U.S. STANDARD.

STEAMED	WEIGHT BEFORE STEAMING LBS.	WEIGHT AFTER VACUUM	WEIGHT AFTER TREATMENT	INCREASE IN WEIGHT	PER CENT OF INCREASE	TIME IN CHLORIDE SOLUTION HRS.	PRESSURE PER SQ. INCH	KGMS OF PURE ZN.CL. ABSORBED PER CU. METER	REMARKS
5 HRS	3.164	3.142	5.557	2.394	76.6	1.90	100	.326	RUN 123 CYL. 1
" "	3.214	3.282	6.618	3.403	105.9	"	"	"	" " " "
" "	3.177	3.276	5.126	1.949	61.4	0.55	35	.288	" 124 " 3
" "	3.236	3.318	4.976	1.740	53.8	"	"	"	
2½ HRS	2.985	3.058	4.556	1.571	52.6	1.95	100	.311	RUN 125 CYL. 3
" "	3.227	3.282	6.977	3.689	114.3	"	"	"	" " " "
" "	3.128	3.203	5.258	2.130	69.1	1.90	"	.322	" 126 " 3
" "	3.914	3.995	6.952	3.038	77.6	"	"	"	" " " "
								Saml. M. Rowe	

WOODS FROM PHILIPINE ISLANDS

RECEIVED MAY 30TH 1908.

Frank M. Rowe.

NO.	LENGTH.	WIDTH.	THICKNESS	VOLUME CU.IN.	WEIGHT OZS.	WT. CU. IN OZS.	WT. CU. FT. LBS.	SPEC. GR.	SERIAL NO.	NAME.
1	6 3/16"	3 29/32"	3/16"	4.5425	2.9513	.6497	70.17	1.1250	#806. T.S.	C. YACAL
2	6 1/16"	3 15/16"	1/4"	6.1001	3.1250	.5723	55.33	.8871	#809. T.S	C. SUPA
3	6 3/16"	3 15/16"	7/32"	5.3295	3.3993	.6378	68.88	1.1044	#799. T.S	C. TINDALO.
4	6"	3 9/16"	3/8"	8.0156	3.5343	.4409	47.62	.8246	#5445 B.F.	ZIZYPHUS ZONULATUS BLANCO BALACAT, BATAAN
5	6"	3 13/16"	3/8"	8.5781	2.6000	.3381	36.51	.5854	#6070 B.F.	SHOREA CONTORTA VID. LAUAAN, TAYABAS
6	6"	3 3/4"	3/8"	8.4375	3.7500	.4445	48.00	.7696	#6045 B.F.	DIPTEROCARPUS GRANDIFLORUS BLCO APITONG, TAYABAS
7	6"	3 11/16"	7/16"	10.3700	4.7500	.4580	49.46	.7931	#6064 B.F.	DUNGON OR MALARUNGON, TAYABAS.
8	5 15/16"	3 7/8"	3/8"	8.6280	5.5230	.6390	69.01	1.1065	#5017 B.F.	HOPEA PLAGATA ? VID. YACAL, ZAMBAL.
9	6"	3 3/4"	13/32"	9.1406	4.1521	.4675	49.41	.7922	#5955 B.F.	DIPTEROCARPUS VERNICIFLUUS PARAO, BATAAN.
10	6"	3 13/16"	3/8"	8.5781	4.2730	.4993	53.92	.8646	#5278 B.F.	KOORDERSIODENDRON PINNATUM MERR. AMUGUIS, BATAAN
11	6"	3 7/8"	7/16"	9.6906	4.3750	.4515	48.76	.7818	#6093 B.F.	INTSIA BIJUGA O. KTZ IPIL, BASILAN
12	6"	3 11/16"	3/8"	8.2969	3.7500	.4600	49.68	.8000	#6056 B.F.	SHOREA GUISO (BLCO) BLUME GUIJO, TAYABAS.
13	5 15/16"	3 11/16"	15/32"	10.2630	3.3070	.3222	34.80	.5570	#1570 M.	SHOREA SQUAMATA DYER ALMON (WHITE LAUAN) NEGROS
14	6"	3 3/4"	1/2"	11.2500	5.0343	.4475	48.33	.7749	#6324 B.F.	SHOREA POLYSPERMA TANGUILE, BATAAN
15	5 31/32"	3 15/16"	1/2"	11.7559	5.7730	.4911	53.44	.8503	#5344 B.F.	CASUARINA EQUISETIFOLIA AGOO, ILOCOS SUR.
16	6 1/16"	4 1/32"	15/32"	13.4560	5.0343	.3741	40.40	.6477	#2961 M.	CYNOMETRA INAEQUIFOLIA A. GRAY BATITI, MASBATE.
				142.4327	64.6646					

Speciment Seasoned.

Department of the Interior

BUREAU OF FORESTRY

ABG-TWP

Office of the Director. MANILA. April 14, 1908.

Mr. Samuel M. Rowe,
C/O Rowe & Rowe,
Room ~~#364~~ Monadnock Bldg.
Chicago, Ill.

Sir:-

In compliance with the request of Mr. W. B. Poland, Vice President of the Philippine Railroad Co. of this city, I have the honor to state that there have been forwarded to you under separate cover, copies of the following publications of this Bureau: Bulletins 1, 4, and 7. Also two packages containing samples of some of our most important Philippine Woods, as per the following list:

Ipil	Molave	Yacal (2)	Dungon	Guijo
Supa	Apoho	Amuguis	Apitong	Panao
Tanguile	Balacat	Lauan	Batete	Tindalo
Almon				

Of these, Tanguile, Apitong, Panoa, Lauan and Almon are sufficiently abundant to export in large quantities. Apitong, Panao, and Tanguile are stronger woods than Lauan and Almon.

Very respectfully,

George P. Ahern

Director of Forestry.

Through the Secretary of the Interior,
Manila.

RECORD OF RESULTS OF CHEMICAL TREATMENT OF TIES.*

By Samuel M. Rowe.

April 15th, 1908. One of the most carefully made and most complete records that it has been possible to secure of an almost continuous record of a large quantity of treated railroad ties is given below. The example is based upon the ties treated by the zinc tannin process in 1885 at the Las Vegas treating plant of Santa Fe Railway Co., and laid the same year mostly on the New Mexico divisions. The computation is more particularly confined to this one year because this lot should now be necessarily quite exhausted at 22 years.

The number of ties treated in 1885, was 111,503, about one-third pound of pure zinc chloride, being used, 1-10 lb. of glue mixed with the zinc chloride and 1½ per cent strong, applied first and about the same amount of tannin extract made into a ½ per cent strong water solution applied after the chloride and glue solution was withdrawn, in accordance with the well defined zinc tannin process then known as the Wellhouse treatment.

The record of removals was neglected until about 1897 at which time the record of these removals was commenced and from that time carefully kept up to and including 1907. At the close of 1907 the record shows that out of the 111,500 ties about 77,000, including 1,300 removed last year (1907), twenty-one years after being put in track and leaving 34,500 ties in round numbers to show for the removals of the earlier years when no record was kept. A computation of these unrecorded ties that failed to be recorded was estimated at about 36,000, indicated that the number was a trifle over-estimated a little, being

*Report made to the Committee on Ties and on Wood Preserving A. R. E. and M. of W. April 15th to 30th, 1908.

based upon the rate of failure for those treated in subsequent years. Beyond the lack of the record for the earlier years, this record is remarkable.

Some small sources of possible error exist on account of the light stamp then used by which a small number became illegible and from the probability of there being still a few not yet removed as over one per cent in 1907. The further source of premature renewals too, will cut some figure on account of the almost entire ballasting of the line on which these 1,885 ties were laid during the last six years.

RECORD OF REMOVAL OF ZINC TANNIN TREATED TIES ON THE NEW MEXICO & COLORADO DIVISIONS.

Treated in 1885 at Las Vegas, New Mexico.

1885		No. Rem'r	Av. yrs. ser.
1 year	1886	11	11
2 years	1887	34	68
3 years	1888	67	201
4 years	1889	261	1,044
5 years	1890	564	2,730
6 years	1891	1,655	9,930
7 years	1892	2,595	18,165
8 years	1893	4,432	35,464
9 years	1894	5,658	50,922
10 years	1895	6,615	86,150
11 years	1896	7,547	83,017
12 years	1897	13,551	162,612
13 years	1898	15,745	204,585
14 years	1899	11,484	160,776
15 years	1900	8,440	126,600
16 years	1901	4,472	71,662
17 years	1902	5,878	41,146
18 years	1903	3,278	59,004
19 years	1904	4,695	89,205
20 years	1905	4,633	92,660
21 years	1906	3,046	63,966
22 years	1907	1,300	28,600
23 years	1908		
24 years	1909		
		105,934	1,388,508
			Av. 13.11 years

The foregoing statement is made up from and including all the records that have been kept by the A. T. & S. F. Ry. Co. at a great expense and comes as near a thoroughly reliable record as is possible on such an extended scale, as a member of the tie committee of your association the writer has been laboring to secure the adoption of a single plan by which

the same end can be secured with a necessary degree of accuracy and at the least expenditure of time and labor. By means of the plan outlined, and in the form herein proposed to be confined to a limited section of track at a sufficient number of representative points.

The statement herein, it must be remembered, is the result of the record of one lot of 111,503 ties treated at Las Vegas, New Mexico under the direction of Joseph P. Card, Mr. Wellhouse, the patentee of the Wellhouse or zinc-tannin process and of Octave Chanute, a pioneer in this business, to whom should be credited the results attained. I do not take this credit to myself as my knowledge at that time was obtained direct from these gentlemen, whose directions were carried out faithfully as possible.

It may be said in passing, that the rules then laid down were based upon many previous years of experience, and subsequent experience indicates that these rules have proven to be based upon well determined facts which are as true today as they were then.

While this statement indicates a life of 13.11 years, it might have been still better if more care had been exercised in selecting the ties to be treated. Many thousands of the ties treated that year had progressed so far towards decay that the treatment could do but little good and the absorption of chemicals was excessive.

This sketch seems very eccentric in its angularity but the matter of faithful record is so important that we cannot afford to give it otherwise, although we know that the laws of nature act very different from that governing the road force. We must have true knowledge and an accumulation of a series of facts before we can convince those most interested, but not conversant with the matter, before the business will be saved from those interested is promoting new patents or new interests, or those

who will not accept anything except what accords with their own theories or interests. An arrogant assertion, if well pressed, will often obscure what is known to be sound facts and well established.

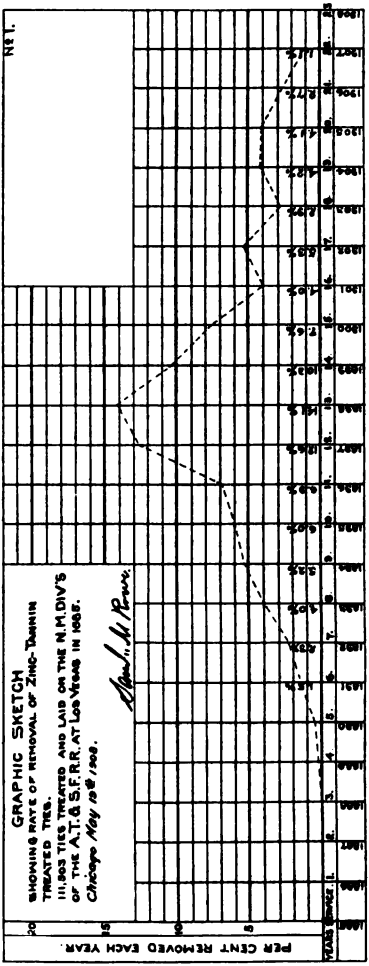
When these mountain pine ties were treated, the fact was already established that the chloride of zinc was one of the very best agents for the preservation of woods. It was known that steam was the most effective agent for securing impregnation; it was known that steam at high pressure would scorch the timber fiber, but that at 250 deg. Fahr., the fiber would not be materially injured; it was known that too high pressure would injure the wood by parting the fiber, but that it would bear 100 lbs. pressure of the sq. in. during impregnation, etc., etc. All these are as true today as then.

The claim is now made that creosote is the only agent of value. It is not denied, indeed it is well known, that creosote where it is possible to well impregnate the timber, gives the highest known results. There is, however, another well known fact that should not be lost sight of, to wit, that full impregnation costs beyond what the railroads can afford; and again, that a very minor portion of the timber which should be treated can, by any known process, be impregnated with creosote, except perhaps in the shape of paving blocks or short lengths of timber which can be reached from the ends.

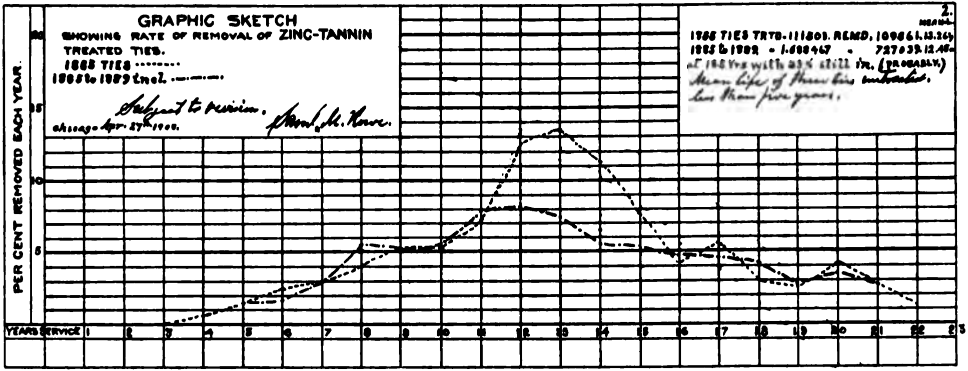
The new methods being industriously promoted; that of partial impregnation, is of more than doubtful value, and it would seem unwise to spend large sums of money in expensive works and in so treating railroad ties; not having the evidence of the value of the treatment.

All these were recognized as facts by the man who directed the treatment of these ties twenty-three years ago, and they are just as true today as then.

The additional fact we now have is that those pine ties with only an average life of four or five years. untreated have been given a life of over thirteen



1885 TIES TO DATE.



1885 TO 1889 TIES TO DATE.

years, or three times that of the untreated. At that time, (1885), there were in evidence ties that had been treated and in track seventeen years and were still sound.

In accumulating these records, careful, honest treatment, both of the subject and on the part of the operator in carrying out this policy will secure desired results, and conduce more to good works and good results throughout.

Chicago, April 15, 1908.

April 28, 1908. I transmit a diagram of results of the Zinc-Tannin Treated Ties, treated at the Las Vegas Plant in 1885, and also a consolidated diagram of the 1885 to 1889 inclusive. The account is not yet complete, so that some modifications can be made later.

I submit this now for several reasons, first; because this data has been obtained at much cost of time and expense by the Santa Fe officials, and although incomplete, are probably the most extensive and valuable records ever rendered in this or any other country, up to this time, and will become more and more valuable as time passes.

The most cogent reason, however, at this time, is to still further impress on the association the importance of impressing the urgency of some well devised method of securing a more comprehensive and more easily applied method to secure reliable data. This is necessary to block the operation of some who are promoting and practicing new or heretofore untried methods, probably of little value, to result in loss and disappointment to the railroad people represented by the Association. Further facts will be given as secured.

April 28, 1908.

April 30, 1908. In submitting these estimates of mean life of railroad cross ties deduced from the records furnished by the timber department of the A. T. & S. F. R. R. Co., we are able to enter somewhat into the realm of fact. It will, however, be

years yet before the whole benefit will be reached. There is, however, now enough to place beyond doubt the benefit derived from the chloride of zinc treatment and to prove that under many adverse conditions the life of ties is three times that of the same kinds of timber untreated. It is proper to now assume that prolongation carries the life of the tie beyond the life of any sound timber under mechanical wear. This being the case, where is the sense of resorting to unproved methods costing twice or three times as much?

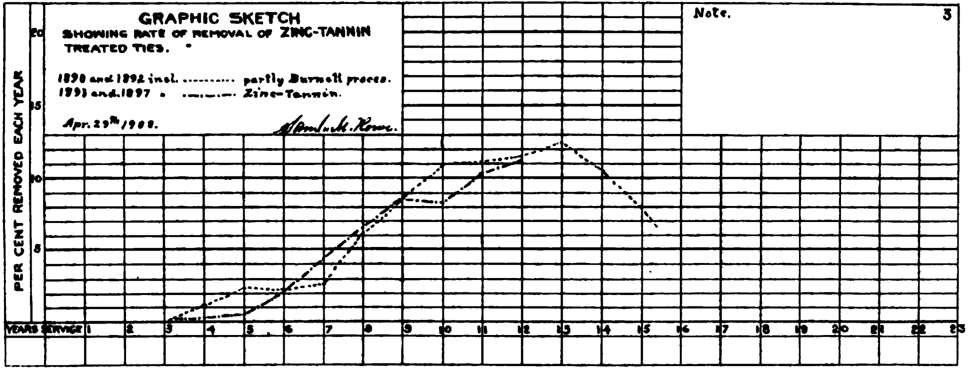
The value of experience, versus theory, is well illustrated. A few years since this chloride of zinc treatment was pronounced a failure and "a waste of money," the dead oil of coal tar being pronounced the only resort.

It is not denied that the creosote is an excellent agent, but it was long since found too expensive to be economical for treatment of railroad ties. That a small amount of creosote can be used in connection with the chloride of zinc to some good purpose, seems probable, but alone; no, in most cases unless the timber be rotted.

The ties in this case of the A. T. & S. F. suffered much from the partial decay as from the actual knowledge of the writer, quite a per cent of those treated were *overseasoned* and beyond the time that the chemicals would be any benefit. Probably those coming out previous to the eighth year would be those referred to. The writer will have something to say in regard to this question of "SEASONING" before treating.

Referring back to the sketch of results on five years,—1885-1889, dated April 27, 1908, which gives 12.45 years, mean life up to 18½ years, and 33 per cent still in; should these ties last 2½ years; the mean life would reach 15 3-10 years. The 1885 ties, nearly all our would as corrected be 13¼ years.

Sketch of April 29, 1908, covering two groups, 1890-1893, covering years when many ties were treated by the Burnett process, shows mean life of



PARTIAL RECORD OF THE MORE RECENTLY TREATED.

10.9 years, at the 15th year, and 14 per cent still in, and the Wellhouse (Zinc-Tannin) treated ties gives at 11th year, a mean life of 10.9 years, with 60 per cent still in. These figures are hastily made and are held open to corrections, but it is apprehended that later estimates will hardly break the force of these deductions.

The A. T. & S. F. Co., certainly deserve great credit for thus securing a very faithful and valuable record.

"Wanted"—An authentic record for creosote or other vaunted processes. The writer has been urging the adoption of a well devised method of securing such records for several years back and hopes that it will be taken up and acted upon. In this connection would urge the stamp marking of the ties when being treated, even should other marking be used when the ties are laid. A sample of stamped figures will be offered at the committee meeting, 6th proximo.

Chicago, April 30, 1908.

PROPER METHODS OF TREATING TIMBER*

Sir: One necessity in the conservation of our timber resources is that of economizing in the use of railway ties, which now form one of the largest demands on the timber supplies. In the earlier days when timber was plenty or easily obtained, little attention was given to the matter, but when the railways had exhausted the local supplies of good timber they had to transport ties for long distances and to use less durable timbers. The necessity of economy in the supply and use of ties then became imminent and had to be met. This point was reached in this country about 25 years ago, and possibly at an earlier period in the old countries.

Previous to 25 or 30 years ago, however, the matter of timber treatment was studied in a desultory way, mainly by individual effort in the line of econ-

omy and not so much as a necessity. At the present time the necessity has become pressing, and attention is being given to the use of steel and various other substitutes. The possibility of a satisfactory substitute seems remote, however, as yet. This being the situation, it seems of the utmost importance that the very best methods of timber preservation should be found and that the experiences of the past should be heeded. No method built upon theory alone can be evolved. In the first place, those agents that will preserve wood from decay must be ascertained, and in the second place, the best methods of application must be sought.

At the time that the writer first came into contact with this subject in the line of duty there were but few agents that seemed to be recognized as effective. Among these were the dead-oil of coal tar (creosote) and chloride of zinc. Both of these still stand ahead of all others.

The value and economy of the former is conceded for special purposes, such as resistance to marine borers, or where prolonged life is sufficiently important to justify the expense of full treatment. But for railway ties, the cost is too great, and is not justified in view of the better results that may be (and are being) obtained from the much cheaper chloride treatment. In relation to partial treatment with creosote, past experiences are not encouraging.

The method of the application of the agent to be considered, covers the physical laws governing the various parts of the operation, and also the physical character of the woods to be operated upon. The writer, with aid from others, has endeavored to cover this ground, deducing his knowledge from experience and careful study, and from oft-repeated experiments. These investigations, studies and experiences have extended through a series of nearly 25 years in this country, supplementing that of some of the soundest and most successful timber treating experts in the country. It is claimed that European countries are far in advance of this country in this matter, but the

writer has doubts of this. Very little information as to details such as the practical operator must possess have been offered from foreign sources.

It is satisfactory to be able to say that some definite results have been obtained by a cheap and simple method with the use of chloride of zinc-modified by the use of glue and tannin as a retardant (the Wellhouse process). By this process and by others not so well defined, the poorer and less valuable timbers have proved very lasting. If the screw spike was used instead of the old-fashioned spike, the mechanical destruction of the tie would be checked and the life still further prolonged.

The agitation and present effort now being made in regard to the collection of reliable data it is hoped will add to the data now possessed. Too often, claims of results that are misleading have come from interested promoters.

Now that the results of timber treatment are becoming known and the value of the treatment of ties has been demonstrated, there is a general movement among the railways to resort to such treatment, largely from necessity. This is due to the growing scarcity of tie timber, and the increasing cost. There is also a desire to aid in the conservation of the forests by the resort to the substitution of softer timbers, which are not adaptable for use as ties unless treated. Recently, under the inviting prospects in this timber-treating business, certain new processes have appeared and new methods have been formulated, under new and plausible theories that seem to have appealed to a certain extent to the railways. The main reason given for these processes is the alleged failure of anything of value having been put into practice in this country. According to these new authorities, everything heretofore offered and practiced may as well be "rubbed out." It is a severe thing to say that this new influence and teaching has

the appearance of arising from a desire to invade this promising field for commercial interests alone.

In the first place, the new methods are offered on faith and on untried theory. They are without the "test of time," and are in the face of many failures in cases equally plausible. Some of the claims seem to require a reversal or at least a modification of natural laws. Others as noted above, throw discredit upon what has been done already in this country. With the present state of knowledge as to methods of which we have long experience, it is absurd to claim that an untried method shall negative all our past practice and research.

The writer has given the matter much time in careful investigation, and has spared no expense to get at the facts, without aid from any outside source. He cannot patiently accept the present situation, or allow these unwarranted assumptions to go unchallenged. The absurdity of the conclusions, and the industry with which they have been pressed upon the railway managers, while being made a source of profit to the promoters, makes it important that their nature be understood. To argue this would be a labor almost in vain, unless railway officers and managers make a greater effort to fully usderstand the nature of the business before making an expensive contract such as is involved in a treating plant and its operation. The railways should be advised to build and operate their own plants, and be able in this way to fully control their operations.

Samuel M. Rowe, M. Am. Soc. C. E.

364 Monadnock Block, Chicago, June 15, 1908.

*Engineering News, July 2, 1908.

SHOULD THE RAILWAYS OPERATE THEIR OWN TIE-PRESERVING PLANTS OR HAVE THE WORK DONE BY CONTRACT?*

Sir: Referring to the article written by Mr. S. M. Rowe in your issue of July 2, entitled "Proper Methods of Treating Timber:"

The Wellhouse process for the treating of timber is being gradually dropped for the reason that the extra cost is not justified by the increased life of the material treated. Creosote oil is fast becoming recognized as the only efficient preservative for timber treatment. It is true that zinc chloride, in some localities, has been fairly successful, but to take it as a whole it cannot be considered so.

I wish to draw special attention to Mr. Rowe's remarks near the close of his article, wherein he states that railways should be advised to build and operate their own plants, and to be able in this way to fully control their operations.

For many years I did timber treating work for one of the largest railway systems in the United States, and naturally I would not criticize their methods of treating, or the manner in which they operate their plants. I can say, howver, that leading railway companies who have treating done by commercial plants, are most rigid in their specifications, requiring all material to be brought up to the standard of perfection before it will be accepted; but in their own plants they cannot see the necessity of employing thoroughly competent and experienced men for operating, for the reason that they are not willing to pay the salaries that competent men command. The result is that many railway companies are building large and expensive wood-preserving plants and placing men in charge of them who know absolutely nothing about the principles of wood preservation. The consequence is that

they are merely training up men, who, by the time that they are in position to be of value to their own company, are seized by large commercial concerns, who recognize the necessity of having experienced and competent men to operate their plants, in order to fulfill the specifications in connection with the treatment of railway and government material.

The result is that the railway companies waste hundreds of thousands of dollars in the operation of their plants by having inexperienced and incompetent men to handle their work for them.

Why then advise railway companies to build and operate their own plants, when large commercial concerns have been organized, combining experience and capital, for the successful operation of their plants?

By having men in charge who have had years of experience, most of them having been trained up with railroad companies and who fully understand the requirements for treating timber, it stands to reason that large commercial concerns can treat material much cheaper, and get out a far superior product as a result of continuous operation.

Yours truly, F. D. Beal.

Eagle Harbor, Washington, July 10, 1908.

*Engineering News July 30th, 1908.

Mr. Beal has the thanks of the writer for his courteous criticism of the position taken in the article referred to, but we still beg to demur to his conclusions.

That the tendency is altogether to the use of Creosote as the only effective preservative of cross-ties, is both hasty and erroneous. Several are still using the Chloride of Zinc and some of them are making further use of this agent in connection with a limited amount of Creosote oil with a good promise of excellent results and furthermore we feel quite sure of results both satisfactory and economical; we believe too, that some who abandoned the Chloride treatment some little time since will find that they made an expensive and ill considered mistake.

In relation to the position that a commercial treatment can better be done, we beg to still adhere to the position taken.

The kind of a man that a railroad company will choose, is such as will faithfully conserve its interest in faithfully performing his duties to the best of his abilities and there is no reason that he shall not be equally competent after proper training and experience. To a man placed by his company in such a responsible position as this does usually feel bound to by every incentive of honor to perform his duties most faithfully and with his utmost ability. Such a course, is of course in such a case, the readiest way to advance his own interest. On the other hand the manager of a commercial plant has, no matter what his abilities, the incentive constantly before him to serve the interests of his employer.

In regard to Creosote as the only agent for the treatment of railroad ties we, at the risk of reiteration, will say:

In the past both in this country and in others a much prolonged life has been secured by a plentiful use of Creosote oil, presumably of about the quality now being generally used in this country. (There

being no definite information to the contrary.) This oil is of such nature that perhaps the best knowledge is obtained by fractional distillation such as any novice can carry through and which will identify variously constituted oils. Much has been written, but little in the shape of definite knowledge has been elicited as to the preservative value of the various constituents, the main point gained being to settle upon a uniform method of distillation by which oil may be compared. In practice, however, there are certain facts elicited that are properly to be considered in placing a true estimate on the value of Creosote. Its value as an antiseptic taking it as a whole, the good results must attest. The wood preserving experts of the government should determine the value of each component part as we have suggested, (Preservation of Timber, Page 242-3), some three years since but not yet done.

It is probably safe to say that most of the remarkable results in treating ties and timber are secured on soft open woods, or possibly on those consisting largely of sap timber. Experience shows that Creosote oil can by no known process of impregnation be made to penetrate sound, well grown heart wood in any case of the so called hard woods. The writer has not seen a single case where a sound Red Oak tie has been penetrated to the heart, while he has seen many that after being over-seasoned to the verge of decay or worm eaten as many are.

The fact remains that many of the woods, which, if treated, would make the best and most valuable ties will only take the Creosote superficially.

They are simply well blacked.

I would be pleased to refer Mr. Beal back to a very able address Jan. 18th, 1905, at New Orleans, made by him before The Wood Preservers' Association.

CHLORIDE OF ZINC AS AN AID IN IMPREGNATING PILES WITH CREOSOTE.

In Creosoting piles, especially the harder and more valuable woods by the best known methods of the present time, little more than a superficial impregnation is secured even with the much increased pressure. In Marine work the thoughtless act of trimming off a protruding knot will break the necessary continuity of the protection and let the teredo work its mischief. There are three treating plants now operating, using the Zinc-Creosote process, each of which are operated by as bright and able operator as is to be found in this country and who all agree that the Creosote oil is carried much farther into the wood than it is possible to penetrate with the Creosote alone. Observations on the output of several hundred thousand ties per month are confirming this fact, and the writer hopes to be able by the aid of these operators to give a confirmation in the near future.

The only necessary change in the treatment is to increase the proportion of Creosote oil used. It is easy to comprehend the importance of this to the treatment of piles for all uses as the thorough impregnation of the piles with the Zinc-Chloride with a more extended penetration of the Creosote will mark an area in the treating of Piles, Ties and Timber.

PLAN FOR CULTURE ROOM

For ordinary amateur room, the most suitable location is in a basement room with masonry walls (or concrete) where the temperature will be measurably equable winter or summer, or it may be partitioned off from a larger room with brick, terra-cotta or concrete walls. An earthen floor or of concrete which is better, will do.

A room 10 feet long and 8 feet wide will probably be sufficient in area, with a door two feet wide and a small window closely fitted for the purpose of observing a hygrometer set on inside of the window for directing the observer to control the degree of moisture in the room.

The bins or benches will be best constructed of reinforced concrete; should be made in the form of a shallow trough and arranged on each side of the room, the first or lower trough on the floor leaving a clear walk through the middle of the room. The second, not less than 16 inches above the lower one, receding from the center walk, much as is done with the benches in a florist's room. And so on to any desired height, or which the height of the room allows.

As the length is too great to support itself, two or more supports may be placed on the shelves or troughs. A small drain should be provided to carry off any surplus water that may incidentally collect, but should not allow the entrance of a draught of air, as the less ventilation the better. Then quoting from Prof. Perley Spaulding, Pathologist of the Bureau of Plant Industry, Washington, D. C.:

> "It will be found after getting fairly started that it is advisable to use comparatively small test-blocks, so as to obtain results fairly rapidly. The size of these test-blocks should, of course, be uniform in a given experiment, and the chances are that it would be much better if they

were uniform in all experiments, so as to give a basis for comparison between different experiments.

"Ordinary soils may be used, but in order to make the experiment of value, it should be thoroughly sterilized by steam or dry heat before being placed in the compartments. Dry heat is probably preferable, as under ordinary conditions the sterilization will be more complete when performed in this way. Having built your compartments and placed the sterilized soil therein, you are ready to obtain the fungi with which to inoculate your test pieces. Of course, the most accurate way of doing this would be by growing pure culture of the different fungi and placing them in the soil which is to be used. Practically, however, and for the sake of quick results, it is probably better to obtain a considerable quantity of wood rotted by certain fungi with which you wish to work; for instance, a considerable portion of a railroad tie which has been rotted by Latinus lepideus would make a very good means for starting with that fungus. It is, of course, necessary to pick such a timber as has no other fungus growing visibly upon it, and also one that is fairly well rotted by the fungus wanted.

"Reasonable care in this respect will insure practically pure culture; at least, there need be little apprehension as to the obtaining of two or more wood-rotting fungi in this way.

"A compartment one foot deep, 3 to 4 feet wide, and two feet long will easily accommodate a series of a hundred or more test blocks, 2 to 3 inches wide, and 12 to 18 inches in length, provided these are placed upright, which, in my opinion, is the proper way of placing them. In this way one has left above the soil several inches of wood, upon which may be placed a suitable label for distinguishing each block from its fellows. (It is suggested that a 2x2 inch

block, 12 inches long, would be the best dimensions, as the concrete troughs will retain nearly permanent moisture and that 6 or 8 inches of earth would be enough. "R.")

"It is necessary to supply water about the same as one would to an ordinary greenhouse crop. It is also best to have fairly warm temperature (not above 100 deg. Fahr. "R."), as results will be obtained quicker than they will if the temperature is cool.

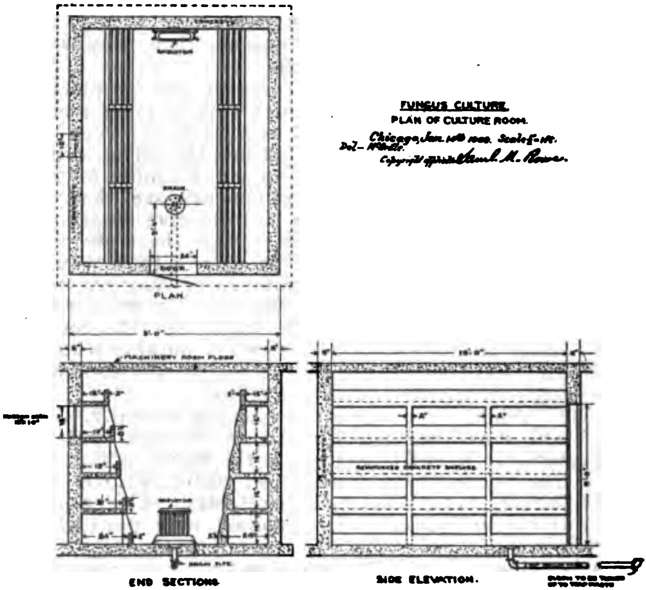
"Too great expectations must not be placed upon the rapidity with which rotting takes place in such an experimental test-room, as even in nature it takes a number of months for an ordinary sized timber to rot, under the most favorable circumstances. The chances are that in some respects your room will not give favorable conditions in all particulars, and therefore the action may be even a little slower than would naturally occur out of doors. You may reasonably expect results from the ordinary wood-rotting fungi in one year's time with the most easily rotted woods. If the more durable woods are to be tested, the results will be correspondingly long in becoming evident.

"While water must be applied liberally, the soil must not be allowed to become water-soaked; it must be kept fairly moist, about as one would do in raising an ordinary crop of lettuce, or other small vegetables. This point is one which must be watched with particular care.

"Some fungi will do well with a large amount of moisture, while others will do equally well with very little. It will take some little knowledge of the natural growth of the different fungi to hit the correct degree of moisture and heat to be used."

Both temperature and degree of moisture to be used will be determined by trial, the water and heat being convenient, the moisture for the air can be

furnished by a slight jet of steam, which will furnish this under the control of the operator—the hygrometer furnishes the indication or guide. There should be no ventilation except what is unavoidable by entering the door, the ceiling of the room to be airtight.

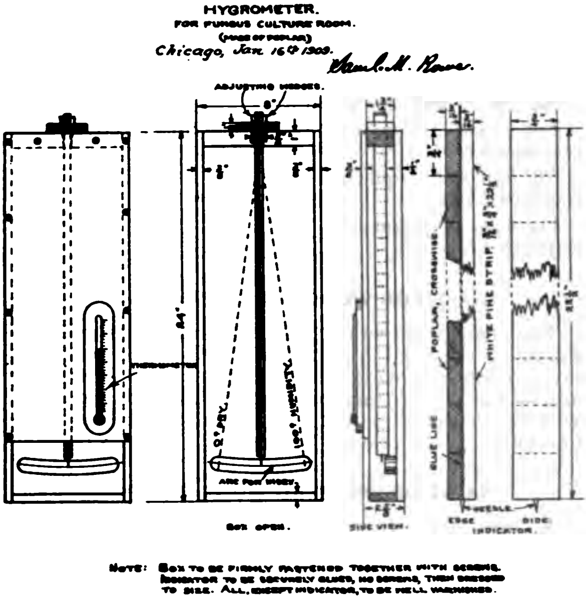


FUNGUS CULTURE ROOM

The room should be well lighted for inspection by electric lights turned on on entering, and one so placed as to light the hygrometer whenever needed, from the outside of the room, as well as a common thermometer (Fahrenheit), to be placed by the side of the hygrometer in the same light.

The room should be heated by a small steam heater as shown in plan of room, and a simple arrangement by which warm water can be drawn as needed, using a sprinkling pot to apply it to the culture soil.

The water tank can be placed on a shelf and a sufficient quantity at the same temperature as the room.



HYGROMETER

Accompanying the plan is a simple form of hygrometer that will answer every purpose. It is presupposed that the room has permanent water and steam, and electric light adjacent.

If temporary boxes are used, the front flange of the shelves can be reduced to minimum height. The size of the whole lay-out can be reduced or enlarged to suit the case in hand. "R."

Chicago, January 15, 1909.

ESTIMATES RELATING TO WOOD BLOCK PAVEMENT

Based upon three standards of blocks, four, five and six inch. Using a block 4"x4"x8" there will be required 40.5 blocks to the square yard, equal to 3.[illegible] cubic feet of wood.

For 4 in. deep equal M. B. M., .036 at $20, equal $0.72, requires 3 cu. ft.

For 5 in. deep equal M. B. M., .045 at $20, equal $0.90 requires 3.75 cu. ft.

For 6 in. deep equal M. B. M., .054 at $20, equal $1.08 requires 4.50 cu. ft.

BASE FOR WOOD BLOCK PAVEMENT

The base for wood block pavement should be made of the best quality of Portland cement concrete, properly made and laid, six inches deep; four and a half cubic feet per square yard of pavement will be required, equal to .17 cubic yard, at $5.00 per cubic yard, costing 85 cents.

COST OF TREATING WOOD BLOCKS

A fair net estimate for cost of treating the best woods for paving blocks, giving sixteen pounds of creosote per cubic foot of timber would be at cost of oil put in, would be about one cent per pound of creosote oil put in. Then, for the three classes, the cost would be about as follows:

Four	inch	deep,	3.	cu.	ft.	of	wood,	per	cu.	yd.	48c
Five	"	"	3.75	"	"	"	"	"	"	"	60c
Six	"	"	4.5	"	"	"	"	"	"	"	72c

This gives us a total cost per square yard of paving as follows:

Depth	M. B. M. Lumber	Cub. Ft. Wood	Concrete 4.5 Yd. $5	Cost Wood	Cost Treated	Total Cost
4 in.	.036	3.00	$0.85	$0.72	$0.48	$2.05
5 in.	.045	3.75	.85	.90	.60	2.35
6 in.	.054	4.50	.85	1.08	.72	2.65

In the estimate of 16 pounds per cubic foot treatment is deemed ample for good blocks as the timber that will take more is not deemed suitable for good paving.

The six-inch depth of blocks is suitable for very severe traffic and will perhaps not be over five per cent of the paved area of any city, and perhaps 70 per cent of the requirements will be of the 4-inch, leaving the remaining 20 per cent to the five-inch on business streets.

The pavement here contemplated is intended to be the best that the best material to be obtained for the purpose, whether of wood blocks, concrete or of creosoted wood to be suitable in its texture and strength for wear under the conditions, but not necessarily of high class merchantable timber, as much good wood not so valuable will make good paving.

The present practice of laying the concrete foundation for the block pavement, asphalt, etc., is a good one, and experience shows that even Portland cement need not be specified (see results on Jackson Boulevard, laid in 1895, where Utica natural cement was used), as the value of all cements, even the very best, depend largely upon the method of treatment in laying.

In the preservative process, too, the way it is done is equally important, but there is no question that the true dead oil of coal tar (the genuine creosote) is the most suitable, and if understandingly applied, will give from fifty to one hundred per cent more service than can be secured by some agents and under some practices of today.

Another requirement necessary to make a good pavement is the free use of coal tar pitch in finishing a new laid block pavement, with an accompanying dressing of clean sand, the latter furnishing a slight cushion over the concrete base and a surface dressing while the pitch fills all seams and covers the surface, the sand mingling with the pitch, gives the surface to service at once. A barrel of pitch should cover 20 square yards so that perhaps an increase of cost of fifteen cents per square yard will accrue.

It must be conceded that wood blocks must, to get the best service, be set with the fiber vertical, hence the blocks will be put four to six inches lengthwise of the timber ducts, hence most hard woods can be impregnated with creosote without difficulty under one hundred pounds retort pressure, with absolutely no injury to the blocks and they go into use perfectly sound and with no tendency to break across as in some cases where they are expanded and prepared to check under slight strain by having been exposed to undue pressure during impregnation.

The timber now usually specified for wood blocks at present is the Southern Yellow Pine, but it is probable that there are several other woods that will wear just as well, and possibly better, that will be accepted in time, as the cost of this wood increases in price and experiences show up their suitability.

The demand for wood blocks has grown up very recently and many are entering upon this industry and a few suggestions may not be out of place as to the general policy best adapted to carry out the industry.

If the sawing and treating can be done in the immediate location of a suitable supply of timber, all can be best done in the one location, and if on a line of navigation, the finished blocks can be shipped in the hold in bulk. They can be discharged directly to the vessel and again unloaded, both by automatic carriers, easily erected.

Should the work be distant both from mills and from water connection, then the lumber should be cut to suitable dimensions to be cut into blocks at the treating plant, discharging from the block saws to the cages and thence to the cars that carry them away.

In regard to the method used in impregnating the blocks, much will depend upon this: A block four inches wide and eight inches long should give the best wear, a longer block being more likely to tilt under a heavy load, which would tend to unseat it, and a longer block would be likely to break it in the middle, no matter how well set or supported it may be. The value of blocks, however, will primarily depend upon the selection of thoroughly sound, well-grown wood and should not be subject to any deleterious effects from an impregnating process where excessive pressure has been applied. However treated, not more than seventy-five to one hundred pounds should be used on the retort charge during impregnation.

SPECIFICATIONS FOR CONCRETE FOUNDATION FOR WOOD BLOCK PAVEMENT

Preparation of Street Surface:

Presupposing that the curb and gutter are in place, the surface of the street should be graded to the sub-base, with a bearing uniform in character, well rolled. Then a concrete, as hereinafter specified, shall be made in the immediate vicinity so that the concrete can be taken immediately from the mixing board and be deposited in place, forming the full depth, be it 5 or more inches in thickness, each course against the face of that previously deposited, care being taken that the full quantity shall be sufficient after proper tamping to make the prescribed thickness. If the concrete is machine made, the methods of depositing by the individual shovel load shall still be adhered to. In no case shall the concrete be leveled with the shovel, but must be leveled by the tamper.

Concrete:

A good concrete is made for this purpose with a proportion of one part cement, three parts sand and six parts of crushed limestone or granite, the former being good enough if rock is good, and all dust sifting out with a one-quarter inch mesh sieve be rejected.

Clean gravel and sand if in proper proportion as to dimensions of the different components, may be substituted for the crushed rock and sand.

The Kind of Cement:

If the concrete is mixed and handled as herein specified, a good natural cement will make a good concrete for this service. (See the work by the South Park Commission on Jackson Boulevard from Michigan Boulevard to the south branch, which was made with Utica cement.)

Sand:

The sand to be used shall be what is usually designated as "Torpedo sand," or more particularly a sand in which the grades run from one-quarter inch down in diminishing quantities as well as in size.

Dust or very fine sand to be rejected.

Crushed Rock:

Shall be what may be termed "crusher run," rejecting all that a one-quarter inch meshed screen will take out. Good, clean gravel may be substituted if similarly graded as to size.

Amount of Water to be Used:

The water to be used should be the least as will well wet the components so as to make the concrete of such consistency as to slip off the shovel when finally deposited and no more.

Method of Mixing:

If mixed by hand, the sand should be deposited on a proper board, being followed by the amount of dry cement and the mass turned over and over until well mixed, then the crushed rock or gravel, as the case may be, shall be spread over the bed, the crushed rock being first well wetted, and then the whole mass turned over repeatedly until it has become homogeneous and then deposited in place as before described.

RECENT PAVING PRACTICE

By J. A. MOORE.*

During the season of 1908, approximately seventy-two miles of pavements were laid in Chicago under special assessment proceedings, at approximate cost of $2,825,000.

The amount of various kinds of pavements laid is as follows:

Asphalt	38 miles.
Brick	9 miles.
Granite block	6.5 miles.
Macadam	14 miles.
Creosoted blocks	4.5 miles.

Compared with recent years the amount of work done was about seventy-five per cent. of the normal amount. Several causes contributed to the decrease in the amount of work done, among them being the financial depression, a strike which lasted about six weeks and which finally resulted in the disruption of the "Pavers' Council," a central organization embracing all the paving trades; delay on account of reconstruction of street car tracks and inability on the part of contractors to secure granite paving blocks.

The tendency of the times seems to be toward decreased use of the cheaper paving materials, such as asphalt and macadam, and toward the increased use of granite and creosoted wooden blocks.

The increasing use of motor driven vehicles has demonstrated the unfitness of macadam to withstand their wear. Instances can be cited where good macadam streets have been practically destroyed in the course of a couple of years where they happened to be so located as to draw heavy automobile traffic.

Bituminous macadam, although approximately as expensive as asphalt, will probably be the solution of the automobile problem.

*The great and growing interest of the public in the subject of wood block pavement would seem to justify the reproduction of Mr. Moore's paper in full, abounding as it does in practical information.

Asphalt seems to have passed its crest of popularity as a paving material, although its use will probably exceed that of all other materials combined for some time to come.

Creosoted wooden block is attracting much attention at present, largely on account of being comparatively noiseless. Your modern businessman likes as little to have his slumbers disturbed at four A. M. by the rounds of the milkman as he does to have his attention distracted by the pounding of heavy loads over rough granite blocks during business hours. It is probable that the next few years will see a large number of the down-town streets, as well as many of the outlying ones, paved with this material.

Creosoted block pavements already laid are wearing exceptionally well, and are generally giving good satisfaction. "The South Park" board of commissioners has recently adopted its use for intersections of car track streets with boulevards, the railway companies doing the paving in connection with the reconstruction of their tracks.

During the past season the writer had charge of the paving of Cottage Grove Ave. from Oakwood Boulevard to 51st Street, with creosoted blocks. The work was done by the Parker-Washington Co. at $3.44 per square yard; amount of pavement laid 32,268 square yards, or approximately one and one half miles of roadway. The blocks were treated at Norfolk, Va., by the "United States" Wood Preserving Co. Long Leaf Southern pine, impregnated with an average of 18.13 pounds of oil per cubic foot of timber was used. An engineer was sent to the plant by the City to inspect the treatment. The blocks, which were laid on a six inch concrete foundation covered with a one inch sand cushion, were four inches wide and four inches in depth, and were laid diagonally across the roadway. Expansion joints filled with coal tar were placed next to the curbing and at intervals of 50 feet across the roadway. The street has a car track on it. One side was completed before the other was torn up. The blocks were driven and wedged together fairly tight. Fine sand was used as a filler. Expansion of the blocks due to

the first rains squeezed practically all the tar out of the joints, and considerable trouble has since been experienced by the blocks buckling during heavy rains. The part of the street which is behaving badly in this respect is confined to one side of the street for a space of about four blocks. The reason why this part of the street buckles and other parts do not is not apparent, but is probably due to some different treatment of the blocks. Sand is not the proper filler for creosoted blocks, being too pervious and inelastic. An impervious filler which will prevent any part but the exposed surface of the blocks from becoming saturated with moisture greatly lessens the liability of buckling.

The reconstruction of 109 miles of street railway track (single track measurement) involving the laying of 470,000 square yards of granite block pavement has been accomplished by the two principal street railway companies during the past year. Fifty thousand square yards of this was paved with old blocks which were redressed. The railway companies absorbed 80 per cent. of the available supply of granite blocks, rendering it necessary for the city to delay most of its projected paving of this class to a later date. The principal source of supply of the granite paving blocks used in Chicago in the past has been the quarries of central Wisconsin. These quarries were unable to supply half the blocks wanted last year, and other sources of a supply, such as Sioux Falls, North Carolina and Thousand Islands were drawn on for large quantities. Somewhat similar conditions are in prospect for the coming year, the City probably having two or three times as much granite block paving projected as it will be able to secure. All the street railway paving was done by the companies directly, by non-union labor. The blocks were laid upon concrete foundations, in which their tracks were embedded.

The Chicago City Railways Co. uses granite block "brow" paving outside of its outer rails where the city paves car track streets with other than granite. Two rows of stretchers are laid along the outer rails, the work being carried on concurrently with the city contract. This form of brow paving stands up well where

laid on good concrete foundation, and proves to be quite satisfactory. Grooved rails are used exclusively in track reconstruction.

The city has laid as yet no concrete pavements under special assessment proceedings, although a considerable amount of this pavement has recently been laid, largely in alleys. As a whole it does not promise to wear well, under medium to heavy traffic. Pavement in said alleys laid in the past year already shows marked wear. After the finishing surface is broken through deterioration is rapid. Repairs necessitate taking out the worn out section from the bottom up. It has the advantage of being smooth when not badly worn, is sanitary and very easily cleaned and is comparatively cheap. It will not rot, and, barring the effect of traffic, should become stronger with age. Expansion joints filled with some elastic material should be used in its construction.

Brick as paving material has been used rather more extensively during the past season than for some time.

Grout filler for brick has been abandoned and tar or asphaltic cement substituted on account of the difficulties encountered in keeping traffic off of grout filled pavements a sufficient length of time to allow it to properly set. Grouting when well done, adds much to the length of life of the pavement. Tar fillers are too brittle in cold weather. Asphaltic cement, if properly tempered, will perhaps obviate the above objections. As yet its use in Chicago is too recent to form an opinion as to its merits. Fillers are, after all, not of major importance in the construction of brick pavements. The quality of the brick is the first essential. "POOR BRICKS" has been the cause of discrediting brick pavements in Chicago. Soft brick or brick that is brittle will not stand the traffic to which it is subjected to in this city. A fair sample of brick pavement is on south Dearborn St. south of Jackson Boulevard. This pavement, which was laid a repair job, necessitated by the reconstruction of the street railway tracks, has been laid less than three months. Apparently its length of life will not be greater than two years. It is only fair

to say that the brick in this pavement were rejected by the city brick tester for new work.

A new form of wood pavement has attracted attention of late, has been used by the city to a considerable extent for paving bridge floors and approaches, is known as the Shuman pavement. It consists of strips of boards bolted together in such manner that the edges form a wear surface, and in sections two or three feet square, or of such dimensions as may best fit the space they are to occupy. The sections of pavement are dipped into some bituminous liquid. A sample of this pavement may be seen on Dearborn St. east of the Federal Building. It wears somewhat unevenly and does not promise to have a very great length of life. Exclusive of foundation it costs about $2.50 per square yard. It is probably better adapted to bridges for bridge floors than for any other purpose, as it is light and can be made any desired depth or size of section.

Paper read by Mr. J. A. Moore before the Illinois Society of Engineers and Surveyors, January 28, 1908.

Chicago city prices on finished pavement including 6 inches of concrete but exclusive of curb and gutter:

Asphalt	$2.20	per square yard.
Granite	3.90	" " "
Brick	2.40	" " "
Creos. Blocks	3.50	" " "
Macadam	1.25	" " "

January 28, 1909.

THE OPEN TANK METHOD OF PRESERVING TIMBER; RESULTS OBTAINED WITH TIES AND PAVING BLOCKS*

Sir: A recent issue of Engineering News [Oct. 22, 1908.—Ed.] contains an article by Mr. Howard Weiss of the Forest Service, on the open-tank method of preserving timber. Mr. Weiss states that the Forest Service will welcome all criticisms and suggestions tending to advance the work. Therefore, I take the opportunity of presenting a few facts pertaining to the results obtained from ties and lumber treated by the open-tank or Seely process, "as it is also known," which have evidently been overlooked by Mr. Weiss.

The Chicago, Burlington & Quincy R. R., in 1868, laid 25,000 ties on the New Boston branch of their road, treated by the open-tank or Seely process as an experiment. These ties failed and were all removed in six years. The failure was due to interior rot. The outer portion to a depth of one-half to three-quarters of an inch was apparently hard and sound whereas the inner wood where the creosote oil had not penetrated had completely failed. These ties caused the Burlington considerable annoyance as, to outward appearances, they were in a perfectly sound condition when it was discovered that the interior was completely rotted.

At the time the Burlington Road made this experiment, the open-tank or Seely process was new, and Mr. Seely undoubtedly performed this work to the best of his ability.

The process also failed on the Chicago, Rock Island and Pacific Ry. in six years, from the same cause as on the Burlington, and it also failed to preserve the pine lumber used in the Government Works on the Saint Clair Flats for a longer period than six years.

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*This communication from Mr. Card is quoted here as an answer to inquiries as to the value of the so-called "OPEN TANK" method of treating ties and paving blocks.

The author would simply repeat what has often been asserted, good railroad ties and perhaps any wood that will make a good paving block, would have to be well dried (rotted, using the word in a qualified sense), before it could be well impregnated in this way successfully.

Paving blocks treated by the open-tank process have produced good results in several places. In Cleveland, O., some were in use for about ten years. In the City of Paris all paving blocks which are used under heavy traffic are treated by soaking in open tanks of hot oil. They fail from wear in about eight years, and this treatment answers. The blocks used on the boulevards where the traffic is light are given a larger dose of oil, in this case they are subjected to pressure in closed cylinders. They last about 16 years.

The open-tank method of creosoting will undoubtedly produce good results if it is confined to the treating of blocks, shingles, posts, etc., or in other words small-dimension lumber, and it will not be successful in this case unless the utmost care is taken in the seasoning of the lumber before treatment. As to the treatment of railroad ties by this method, a loblolly-pine tie, provided it is thoroughly seasoned, would probably absorb the greatest amount of solution in the least time, but any other class of ties treated by the open-tank process would take from two to three weeks to absorb the same amount of solution that could be injected under 100 lbs. pressure per sq. in. in four hours time.

Undoubtedly the Seely process failed in the treatment of large-dimensions lumber for the want of proper seasoning; and the length of time it would take to thoroughly saturate the wood was so great that the treatmen was cut short and poor results followed.

The treatment of ties with small doses of creosote oil has not been a success in this country or in Europe, the Robbins process and also the Blyth process failed to give results, and practically all the European countries which are using creosote have for a long time been injecting from 10 to 15 lbs. of oil per cu. ft. of wood, and by so doing obtain a life of from 12 to 20 years.

It can be easily seen where a small dose oil treatment will fail to give results, especially in treating a class of timber like red and black oak and other inferior oaks. This class of timber will rot from the center out in almost all cases, and unless the treatment is pushed to refusal "and this is expensive," it will fail to give as good results as chloride of zinc

where ½ lb. of dry salts per cu. ft. is used. This can be verified by the records obtainable in this country and in Europe.

If the tendency in this country is to return to the open-tank or Seely process, great care and judgment should be used, otherwise the results will be a failure, as heretofore. Yours truly,

J. B. Card, Manager,

Chicago Tie & Timber Preserving Co., Old Colony Bldg., Chicago, Ill., Oct. 26, 1908.

ON SEASONING TIMBER PREPARATORY TO TREATING

The popular belief seems to be general that timbers in the shape of railroad cross-ties, timber and piling must be well seasoned before it can be impregnated by any of the usual methods. The presumption is that if it is "well seasoned" that it is dry, or at least that it contains but a small amount of moisture and that the natural saps have become exhausted of the watery parts by evaporation.

It is the purpose here to call attention to a case where four-inch sections were cut from apparently well air-seasoned ties that had been piled much longer than the conventional thirty to sixty days and from a stock of ties that were being treated in the usual course.

The appended table shows the condition of the named woods after drying carefully for the purpose of testing for compressive strength, the oven being used and temperature below scorching.

No.	Name	Wt.Cub.Ft when rec'd Lbs.	Wt.Cub.Ft when dried Lbs.	Loss Per Ct in weight	Loss Per Ct in vol.
1	Chestnut .	49.8	39.36	29.34	18.32
2	Hackberry	43.0	35.94	21.85	35.52
3	Poplar . .	30.1	22.65	32.81	27.49
4	Willow . .	32.0	23.04	47.37	38.35
Mean per cent of water, taking the mean,				32.84	29.92

The theoretic and somewhat academic rules so elaborately put out for drying or air seasoning, contemplates many expensive operations that could be avoided if ties were taken from the woods and immediately treated and put out on the line where needed. Elaborate and expensive storage yards, several rehandlings of the ties, a year's loss of life of the ties and of money involved, should be avoided.

Ordinarily, considerable time elapses between the cutting and the receipt of the ties at the treating works, often from sixty to ninety days; time enough at least for the breaking down of the natural juices of the timber; experience seeming to point to this condition as a proper time to subject the wood to treatment. There is now very good reason for believing this to be correct and moreover if it is, the very great danger of inducing decay by this seasoning (?) is avoided. All in all, it would seem well to modify pet theories to conform to "experience."

EXPERIENCE IS NECESSARY

In the study of this and kindred subjects the knowledge and abilities should be of a two-fold nature, acquired knowledge and "experience." The former to lay the foundation for the latter and the experience to fill out and mature the judgment thus acquiring practicable knowledge that will be a safe guide ever in the future.

"The parrot can learn to say what others say; no matter how eloquent; the monkey will imitate what others do but in both cases without wisdom."

In physical nature with which we have to deal, all technical knowledge is derived from experience, the very foundation of knowledge, and therefore should not be cast aside, scorned, but should be courted assiduously and its lessons carefully studied. Only in this way will "facts" be adduced. Self-aggrandizement, eloquence of speech or plausible theories and purely technical knowledge without experience is apt to be misleading and mischievous.

TREATING FRESH CUT TIMBER

The actual experiences here given bear directly on this much mooted question. The timbers here treated consist of a variety of the woods grown in upper Michigan and consisting of Birch, Beech, Hard and Soft Maples, Pines, Tamarack, Hemlock, two varieties of Elms, Sycamore, Hackberry, etc. The average size or volume of these ties is 3.3 cubic feet and being northern well grown wood, there is a minimum of sap wood—much less than with the same woods grown farther south.

This timber was cut during the winter 1907-8 and in a climate where it remained frozen until near April, hence could not dry much before operations were commenced upon the treatment. Tests made early in May showed the timber still full of the saps.

The following synopsis of the treatment having seven hours and fifty minutes average time for each run will give a fair idea of the method of treatment, the zinc-creosote, (Card) process being used.

Month of June, Steamed 3½ hours. Under pressure 2½ hours.

Month of July, Steamed 3½ hours. Under Pressure 2¼ hours.

Month of August, Steamed 3½ hours. Under pressure 2¼ hours.

Month of December, Steamed 2½ hours. Under pressure 3 hours.

TABULATION OF RESULTS

Month	Emulsion	Name Wood	Condition	Abs. Znc.	Abs. Cre.	Total Emulsion. Abs. Cu. Ft.
June	4 pr. ct. Z. 20 pr. ct. Cre.	Hem and Tam	Green	.4282	2.19 lb.	10.88 lbs.
July	3 pr. ct. Z. 13 pr. ct. Cre.	Hard Wood	Partly Seasoned	.4224	1.79 lb.	13.83 lbs.
August	3 pr. ct. Z. 13 pr. ct. Cre.	Hard Wood	Dry	.4551	1.99 lb.	15.28 lbs.
December	3 pr ct Z. 17 pr. ct. Cre.	Soft Wood	Dry	.4296	1.83 lb.	10.76 lbs.

The absorption of Zinc is good. The absorption of the oil per tie is as follows:

June 7.23 lbs. per tie for 3.3 cubic feet.
July 5.90 lbs. per tie for 3.3 cubic feet.
Aug. 6.00 lbs. per tie for 3.3. cubic feet.
Dec. 6.50 lbs. per tie for 3.3 cubic feet.

It does not seem that the treatment was retarded very much in consequence of the wood saps.

Pertinent to this question is a report in relation to piles creosoted by the International Creosoting & Cons. Co., in 1895, for the railway causeway between the mainland and Galveston Island. Quoting from the Engineering News,

"At present, all the railways enter Galveston over a single track viaduct about 11,000 feet long supported on creosoted piling and over 4,000 separate piles. Over 2,000,000 cars have crossed this bridge since 1900. * * * The piles used * * * were all of Southern pine treated with 24 pounds of anhydrous creosote oil per cubic foot. They were practically all green when treated, most of them coming from the stump and being seasoned by steaming * * *

Early this year there occurred the lowest water in years in the bay between Galveston Island and the mainland. The water was so low that two-thirds of the total number of piles were exposed to the mud line. This afforded opportunity for a most complete examination of each pile, and the official report of the inspection showed that not one pile originally furnished was in any way decayed."

These instances are new developments but not exceptional. Experiences at Somers, Montana, where ties from the saw were more easily treated than those piled to dry some little time and those experiences noted by W. G. Curtis of the Southern Pacific in California in the early history of the business must also still be held in mind.

TREATING FRESH CUT TIMBER

Dry wood is most easily permeated with zinc solution, and with favorable woods, it becomes possible with

creosote oils, but the danger remains that decay may have progressed during such drying so that the treatment is of little avail.

Summing up the results of experiences of many years would seem to lead to a reliance on the mature knowledge derived from long experience and good judgment and common sense rather than upon that which is largely academic, the experience being lacking. (R.)

RECORDS OF RESULTS

The author recognizing the importance of actual records in determining the value of any treatment, entered into this matter at some length some years since as evidenced in the pages of this work, (pps. 289, etc.) but up to date of writing, little response has been elicited and little has been done to do anything effective. The records offered so far, with few exceptions, are so fragmentary as to be very inconclusive. The plan here offered is simple and measurably inexpensive, but would give all necessary data. Without some such system of inspection and record, the whole matter remains open to the unsupported assumptions put forth by irresponsible and self- interested parties. Fortunately, in a few cases reliable records have been secured. Without carefully kept, long extended inspection and record, little of value can be secured. This inspection should be made under the direction of the railroad company by their own engineers, no expert with a pet hobby or with an ax to grind will be safe to trust.

DOES CHLORIDE OF ZINC LEACH OUT?

Does chloride of zinc leach out of woods treated or impregnated with its solution for the purpose of preventing decay is a question asked and answered so often "that it does," that it is generally conceded to be a fact.

Were it not that this fact is used to discredit the chloride process by interests promoting other processes, some of them at least of very doubtful character, this conclusion might be acquiesced in without further question.

The vital question however is whether this waste is really to such amount or extent as to in any degree impair its value.

Fortunately by the efforts of an operator* of one plant some information right to the point is available, derived from an extended series of tests from conditions much more severe than ties are subjected to in track under the severest conditions found in this or any country.

* F. J. Angier, Chem. Engr., Supt. Wood Preservation, C B & Q R.R. Co

The tests were made as follows:

Twelve each of four different woods were secured and selected after having been treated with zinc-chloride, half pound of pure chloride per cubic feet having been injected.

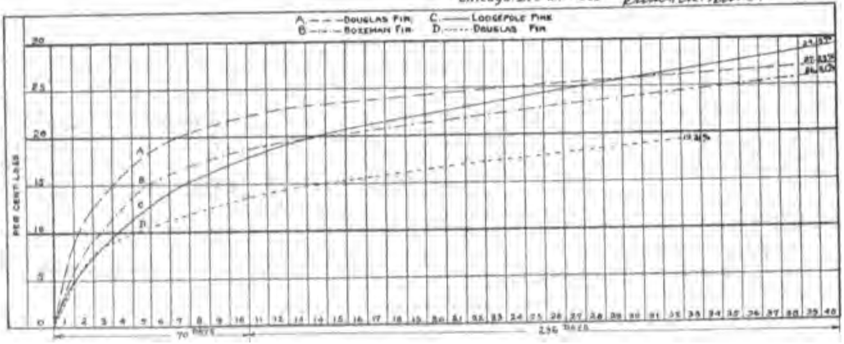
The ties were put in a water bath, weighted down for 24 hours, then dried about seven days, an analysis being made and the ties again returned to the water. This routine was repeated some forty times covering a period of over three hundred days.

The diagram submitted, shows graphically the results from which the following conclusions are deduced.

"Generalizing, by taking the mean of the four kinds of wood it is found that the main part of the loss takes place in the first ten periods or in the first seventy days, approximately 18% of the original amount, and at the end of 300 days, the total loss was 23½%.

Then continuing the rate after the 70th day, then at the end of 15 years the loss would be only 47%, and it would require over 60 years at the same rate to exhaust the chloride entirely."

Chicago, Dec 23rd 1908 Saml. M. Rowe.



ZINC-CREOSOTE EMULSION.

Table 15

TO PREPARE IN SUCH PROPORTIONS TO IMPREGNATE WOOD AT THE RATIO OF 1 TO 6.

Chicago, Jan. 4th 1909.

By Frank McArdle.

Paul M. Rowe.

LBS. REQ'D PER CU. FT. EMULSION.				CU. FT. REQ'D PER CU. FT. EMULSION				WEIGHT PER CU. FT. VARIOUS TEMPERATURES. F.							
% ZINC	PURE ZINC CHL₂	% CREO	CREOSOTE	% ZINC.	50% ZINC SOLUTION	% CREO.	CREOSOTE	60°	100°	150°	160°	170°	180°	190°	200°
1/4	.156	1 1/2	.937	1/4	.0032	1 1/2	.0143	62.53	61.92	61.18	61.04	60.89	60.74	60.59	60.44
1	.629	6	3.780	1	.0130	6	.0577	62.99	62.36	61.58	61.43	61.27	61.11	60.96	60.80
1 1/2	.950	9	5.638	1 1/2	.0196	9	.0870	63.31	62.66	61.86	61.69	61.53	61.37	61.21	61.05
2	1.273	12	7.637	2	.0263	12	.1166	63.64	62.96	62.12	61.95	61.78	61.61	61.44	61.28
2 1/2	1.600	15	9.595	2 1/2	.0330	15	.1465	63.96	63.27	62.41	62.23	62.07	61.89	61.72	61.55
3	1.929	18	11.573	3	.0398	18	.1767	64.29	63.58	62.70	62.52	62.35	62.17	61.99	61.81
3 1/2	2.262	21	13.571	3 1/2	.0469	21	.2072	64.63	63.89	62.98	62.80	62.62	62.43	62.25	62.07
4	2.598	24	15.591	4	.0537	24	.2381	64.96	64.21	63.26	63.07	62.88	62.70	62.51	62.32
4 1/2	2.937	27	17.632	4 1/2	.0607	27	.2694	65.30	64.52	63.55	63.36	63.16	62.97	62.78	62.58
5	3.282	30	19.693	5	.0678	30	.3007	65.64	64.84	63.84	63.64	63.44	63.24	63.04	62.84
"a"	"b"	"c"	"d"	"e"	"f"	g.	"h"								

TO PUT UP EMULSION OF ANY REQUIRED PER CENT FOR EACH VERTICAL TANK FOOT.

BY WEIGHT. – X DESIRED VALUE OF "b" THEN "d" BY TANK AREA.
BY VOLUME – X " " " "f" " "h" " " "
THEN FILL BALANCE OF VERT. TANK FOOT WITH WATER.

WEIGHTS AND EXPANSION OF FLUIDS.

CU. FT.	LBS.	SP. GR.	EXP'N FOR EA. DEG. F.
ZINC CHL₂.	216	3.463	
50% ZINC SOL.	96.79	1.552	.0003504
CREOSOTE.	65.49	1.050	.0004727
WATER.	62.37	1.000	.0002424

COMPARATIVE TREATMENT OF DIFFERENT WOODS. *Table. 29*

THE FOLLOWING TEST WAS MADE AT THE GALESBURG TIMBER TREATING PLANT, IN THE EXPERIMENTAL RETORT. THE CARD PROCESS WAS USED AND IN EVERY CASE THE TREATMENT WAS CARRIED OUT IN THE SAME WAY, VIZ - NO STEAMING, NO INITIAL VACUUM, THREE HOURS SOLUTION, PRESSURE AT 150 LBS., ONE HOUR FINAL VACUUM. SOLUTION CONSISTED OF 23% OF CREOSOTE BY VOLUME AND THE BALANCE WAS WATER CARRYING 5% ZINC CHLORIDE. TEMPERATURE OF SOLUTION WHEN INTRODUCED WAS 180 DEGREES F. IN EVERY CASE.

THE DIFFERENT RUNS ARE TABULATED IN THE ORDER IN WHICH THE WOOD ABSORBED THE SOLUTION. FOR INSTANCE, CYPRESS WAS THE EASIEST TO TREAT, WHILE WHITE OAK WAS THE HARDEST, ABSORBING 7.97 %.

Chicago, Dec. 26th 1908.

Saul. M. Rowe.

				WEIGHT IN LBS				ZINC ABSORBED #		CREO. ABSORBED #		# REGAINED	
KIND.	NO. TIES.	CU. FT.	CU. FT. PER TIE	BEFORE	AFTER	GAIN	% GAIN	PER TIE	PER CU. FT.	PER TIE	PER CU. FT.	LAST VACUUM.	MONTHS SEASONED
CYPRESS.	4	11.04	2.76	301	596	295	98.01	4.09	1.48	16.96	6.15	52	8
COTTONWOOD.	4	10.68	2.67	248	467	219	88.31	2.11	.80	12.59	4.72	96	7
WILLOW.	4	10.68	2.67	306	557	251	82.03	2.43	.90	14.43	5.41	73	8
BIRCH	4	11.01	2.75	421	707	286	67.93	2.75	1.00	16.45	5.98	61	8
WHITE ELM.	4	10.50	2.62	362	581	219	60.50	2.11	.80	12.59	5.11	44	8
POPLAR	4	11.17	2.79	303	481	178	58.74	1.71	.61	10.24	3.67	41	6
SOFT MAPLE.	4	10.68	2.67	348	524	176	50.58	1.69	.63	10.12	3.79	22	8
HEMLOCK	4	11.80	2.95	372	557	185	49.45	1.78	.60	10.64	3.61	45	13
LOBLOLLY PINE.	4	10.68	2.67	346	499	153	44.22	1.47	.55	8.80	3.30	58	8
HARD MAPLE.	4	10.67	2.07	447	629	182	40.72	1.73	.66	10.46	3.92	32	8
RED GUM	3	9.21	3.07	306	419	113	36.99	1.46	.47	8.67	2.81	24	8
BEECH.	4	10.23	2.56	484	661	177	36.57	1.70	.67	10.18	3.91	44	8
RED OAK	3	10.50	3.50	460	625	163	35.87	2.12	.60	12.65	3.61	18	8
ASH.	3	9.00	3.00	383	515	132	34.47	1.69	.56	10.12	3.37	16	8
HICKORY.	4	10.25	2.56	499	613	114	25.85	1.09	.43	6.55	2.56	11	8
TAMARACK.	4	10.19	2.55	414	488	74	17.87	.81	.32	4.83	1.99	9	13
WHITE OAK.	4	10.67	2.67	502	542	40	7.95	.39	.14	2.30	.86	10	8

THE NEW GOSPEL

The Author some time since took occasion to deprecate the influence of "Commercialism on the business of the Preservation of Woods," assuming the position that the railroads could better protect their interests and the trust invested in them in their official duties, a trust all the more sacred in proportion to its magnitude and importance, could best be secured by doing it and holding it in control by the company itself, directly.

There seems, however, to have been a new element, a new phase of ethics at least, introduced into the business; it cannot be called business method; by which the business is being disturbed, for a time at least, by which the sum of acquired knowledge and the experience of many years is thrown aside scornfully and is being replaced or is being sought to be, and an untried method having absolutely no record as to its value as a treatment. Not only this; but it is being forced upon the railroad world to the exclusion of sane and tried methods long known to have been successful.

It is claimed by this new gospel, that it is the essence of wisdom, that it be universally accepted, settling every doubt in the mind of every railroad manager so that he need know nothing more about it, except to wrap himself in an abounding faith and allow his ties to be well blacked after elaborately piling them until they approach the verge of decay so as to allow them to be well (superficially) blacked.

It may be well here to mention that a creosote oil containing a large percentage of coal tar "pitch," will better hide defects in process of treatment, or the addition of a little of the pitch, a worthless substance which costs but little and only retards the oil, deepens the color, etc. (no charge is made for this suggestion) saves money and prolongs the exposure of results.

The most practical result is however that it will turn a bit of money to those in the business of promoting and to the railroads; What?

Furthermore, this is not all: Ordinarily to build and install a treating plant, a notice of such purpose to a competent engineer of experience that such a desire is entertained will at a reasonable compensation, secure immediate attention and an efficient, economically erected and operated plant can be secured. A shop draughtsman with absolutely no practical knowledge of the process cannot be trusted to do this. At this day, however, it is necessary to convince some one. Money convinces; then if common sense interposes, anyone having the temerity to interpose, then he must subside or be crushed. Even the "EXPERTS" trained into this special line by the Forest Service are hired off, due probably to the government stamp being of value to the business, more than for the actual knowledge derived from the limited practical knowledge derived from the accidental connection therewith. Perhaps no greater detriment to sane practice can accrue to the business so important to the railroads and to the conservation of our forests so ably advocated by our President of the United States and our Forest Service, than from these so called experts with the limited practical experience in the matter. "A word to the wise."

VALEDICTORY

About twenty-four years ago the writer was intrusted with the management of the wood treating business for one of the largest railroad companies in the West. This duty was assumed as resident engineer owing loyalty and duty to the railroad company alone. Although having been engaged in railroad service for many years previous, during which my experience passed through almost every department of railroad construction, and operation, the business of wood preservation was new. Shouldering the responsibility, it became a duty to treat the matter honestly, carefully and thoroughly; the first duty was to thoroughly understand it, consequently a study was made of each and every phase as developed by the operation. This study was continued almost unremittingly up to this date, and results have been put into record and are embodied in this work, and

has been furnished to students in all parts of the world.

The methods used are mainly founded on basic principles, theories cutting no figure, and every effort turned to verify by all means in reach, so that in most cases each point can be relied upon as facts. These studies have been carried forward to this time at great cost of money and time, entirely without aid from any source, and with very little recompense from those deriving benefit, either in money or thanks. Although this will be the last work on the Hand Book, the work will be continued to the end that the best possible work shall result eventually, and the author still pledges the best efforts and will not hesitate to interpose where dishonest practices for the simple incentive is the money there is in it. The "Fakir" must have his day, but it will be a short day, and when it ends, not only will he get his deserts, but those whom he has misled, innocently on their part, will have good reasons to mourn.

The mischievous business method which our "Lincoln," whose centennial birthday we celebrate, was too simple minded to even comprehend and against which our president has fought so strenuously, still prevails, and since "Timber Preservation" has grown to be so important, has invaded this field, presumably for the "money" there is in it.

The writer, in one short lifetime has seen the country stripped of the bulk of its woods from the Atlantic coast to and into the continental divide, and at the present day the western slope is being invaded and ruthlessly slashed into. There are children living today that will live to see the country devastated of resources so that it must be on its decline, and our children forced to seek other climes. It is to be hoped, however, that our people will awake to this peril and that millionaire fortunes, however acquired, will cease to be used to impoverish the country.

Chicago, February 12, 1909.

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A CARD TO THE PUBLIC

Our business is to design and install timber preserving plants. In planning a plant to impregnate timber with preservative treatment the aim is to provide for those functions necessary to be performed and to do this in the most direct and perfect manner, in other words to make the plant a complete and perfect machine for the purpose within itself. To do this understandingly it is necessary to adapt the layout to the situation as to grounds, tracks of access, water supply, drainage, and other necessities for its operation. Such matters as the character of the buildings to cover the plant can be left to the judgment of the builder or to any good architect.

The ability to do this well and to do it right is here offered, derived from long continued, careful study and practice such as cannot be possessed by any simple shop draughtsman with no practical experience in the operation of a plant or the principles involved in the art of impregnation of the various woods. Any attempt in this direction on the part of such, will and have always proved abortive, resulting in expensive and clumsy experiment and lacking in many of the essentials of what a modern plant should possess.

Those wishing faithful, honest service at reasonable compensation will not be disappointed, can trust us because we know how.

We will not make estimates of cost unless the management and control be under our direction until the plant is completed and installed, but will give such information as to cost of similar work so far as our past experience enables us to do. We will not be sponsors for other peoples mistakes or extravagance, but would save every expense that will not aid in earning dollars in operation both in expense in methods and management.

CARD.

In compiling this work a large number of illustrations have been introduced to more fully describe the various parts of the workings, but owing to the smallness of the page, most of these are too small to carry much value except to make a record of them.

There are a number of tables of the same character so small as to be read with difficulty. Full sized prints of the plans will be furnished at the regular price for such plans and the tables will be furnished at small advance of cost.

Plans, specifications, inspection of works and installation and also training of an operator is covered by a reasonable and fixed commission based upon the cost of the completed plant.

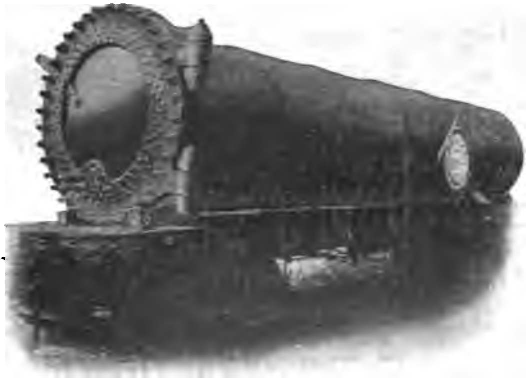
Deviation from plans and specifications will be at risk of the company making the changes.

We endeavor to select everything with reference to efficiency and reliability, at the same time economizing as much as possible.

We accept no commissions on machinery bought and will make no contracts for purchases except at the special request of the contracting company and under a special arrangement.

ROWE & ROWE,

SAMUEL M. ROWE, *Mgr.*



ROWE & ROWE.

TO THE PUBLIC: For eighteen years we have given the business of planning and installing Timber Preserving Works the closest and most careful study, both as to the efficiency of treatment and to the simplification of the appliances. We now believe that we can assure the very best results. Our "Hand Book" containing most of the results of our study, although not intended for publication, has been freely given out, it being our wish to withhold nothing from those really interested. We believe now that our facilities for designing and for installation are unequaled; our terms most reasonable, enabling us to give much of this advantage to our patrons.

We will also, when desired, inspect as to methods and efficiency of treatment by any works, and at moderate compensation.

The following list of works will give some idea of the extent of our experience:

1885. A. T. & S. F. Ry. Las Vegas, N. M. Operated several years.
1887. Union Pac. R. R. Laramie, Wyo. Plans.
1897. T. T. & L. P. Co. Somerville, Tex. Plans, Supervision and Operation.
1898. Santa Fe Pac. Bellemont, Ariz. Plans, Supervisions and Operation.
1898. C. & E. I. R. R. Mt. Vernon, Ill. Plans revised for O. Chanute.
1899. Great Northern Ry. Kalispell, Mont. Plans, Supervision and Installation.
1899. B. & M. R. Ry. Edgemont, S. Dak. Plans, Supervision and Installation.
1900. H. C. Sugar Co. Hawaii, S. I. Plans with full directions.
1900. Mex. Cent. R. R. Mexico. Consulting Engineer.
1901. M. K. & T. Ry. Greenville, Tex. Plans, Supervision and Installation.
1901. Alamogordo L. Co. Alamogordo, N. M. Plans, Supervision and Installation.
1901. Rocky Mt. Timb. Co. Colo. Plans, Supervision and Installation.
1902. Ayer Lord Tie Co. Carbondale, Ill. Consulting Engin'r.
1902. " " " Miss. Consulting Engineer.
1902. Union Pacific. Portable Plant. Shop Inspection.
1902. O. R. & N. Co. " "
1902. A. T. & S. F. Plans and Specifications.
1903. D. & R. G. Alamosa, Colo. Plans, Specifications and Installation.

ROWE & ROWE

SAMUEL M. ROWE, - - - - - Manager.

BUSINESS DIRECTORY.

For the convenience of our patrons and ourselves we introduce this short directory, giving name and address of those dealing in the articles named. This must not be understood as excluding others in the same line.

Boilers.

Kewanee Boiler Co., 167-169 E. Lake St., Chicago.

Hamlin Boiler and Tank Co., 39th and Halsted Sts., Chicago.

Scully Steel and Iron Co., 130-136 Fulton St., Chicago.

Cast Iron Pipe.

F. K. Bowes & Co., 277 Dearborn St., Chicago.

Jas. B. Clow & Sons, Franklin and Harrison Sts., Chicago.

Cables.

Lidgerwood Mfg. Co., Old Colony Bldg., Chicago.

Jno. Roebling Sons Co., 171-173 E. Lake St., Chicago.

A. Leschen & Sons Rope Co., 137 E. Lake St., Chicago.

Chloride of Zinc.

Grasselli Chemical Co., Cleveland, Ohio.

General Chemical Co., 185 Adams St., Chicago.

Hydrometers, Chemical Appliances, Etc.

The Hohmann & Mauer Mfg. Co., 119 Lake St., Chicago.

A. Daigger, 132-134 E. Lake St., Chicago.

Creosote (Dead Oil).

Barrett Mfg. Co., Loan and Trust Bldg., Chicago.

Electric Lighting.

General Electric Co., Monadnock Bldg., Chicago.

Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Glue.

Diamond Glue Co., R. 422, 218 La Salle St., Chicago.

American Glue Co., 148-150 E. Kinzie St., Chicago.

Hoisting Engines.

Lidgerwood Mfg. Co., Old Colony Bldg., Chicago

Lead Sheet.

Raymond Lead Co., 51-59 W. Lake St., Chicago.

E. W. Blatchford & Co., 70 N. Clinton St., Chicago.

Lead Burning.

J. J. Tuttle, 453 Flournoy St., Chicago.

J. J. Wade & Sons, 52 Dearborn St., Chicago.

Pressure Gauges and Thermometers.

Schaffer & Budenberg Mfg. Co., 15 W. Lake St., Chicago.

Pumps and Condensers.

Knowles Steam Pump Works, New York Life Bldg., Chicago.

Wheeler Condenser and Engineering Co., R. 1187 Monadnock Bldg., Chicago.

Fairbanks, Morse & Co., Franklin and Monroe Sts., Chicago.

Pipe and Fittings.

Jno. Davis Co., 22d and Halsted Sts., Chicago.

Crane Company, Jefferson and Randolph Sts., Chicago.

Jas. B. Clow & Sons, Franklin and Harrison Sts., Chicago.

Retorts.

Allis-Chalmers, New York Life Bldg., Chicago.

Chicago Bridge and Iron Co., 105th and Throop Sts., Chicago.

Hamlin Boiler and Tank Co., 39th and Halsted Sts., Chicago.

Scully Steel and Iron Co., 130-136 Fulton St., Chicago.

Roofing, Pipe Covering and Asbestos Packing.

Chicago Fire Proof Covering Co., 18-20 N. Canal St., Chicago.

H. W. Johns-Manville Co., 171-173 Randolph St., Chicago.

Western Roofing and Supply Co., 177 Randolph St., Chicago.

Scales.

Fairbanks, Morse & Co., Franklin and Monroe Sts., Chicago.

Sheaves and Guide Pulleys.

Link Belt Machinery Co., 39th and Stewart Sts., Chicago.

Superheaters.

Power Specialty Co., 126 Liberty St., New York.

Tanks.

Fairbanks, Morse & Co., Franklin & Monroe Sts., Chicago.

W. B. Rose Supply Co., Lincoln Trust Bldg., St. Louis.

Wm. Graver, Tank Works (Steel Tanks) 303 Dearborn St., Chicago.

Tram Cars.

Fairbanks, Morse & Co., Franklin & Monroe Sts., Chicago.
Chicago Bridge & Iron Co., 105th & Throop Sts., Chicago.

Tannin.

Northern Extract Co., 144 Kinzie St., Chicago.
A. Klipstein & Co., 122 Pearl St., New York.

Track Fixtures.

Paige Iron Works, Room 427 Monadnock Bldg., Chicago.
Ajax Forge Co., 138 E. Jackson Blvd., Chicago.

Valves.

Chapman Valve Co., 28 S. Canal St., Chicago.
Eddy Valve Co., Waterford, N. Y.
Jenkins Bros. Valve Co., 31-33 N. Canal St., Chicago.

Differential Pulleys.

H. Channon Co., Market & Randolph Sts., Chicago.

ILLUSTRATIONS.

ILLUSTRATIONS—Continued.

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